Appendix C

Responses to the Theory of "Benevolent Market Power"

Policy White Papers Prepared by Trevor R. Roycroft, Ph.D.

1. Network Diversity—A Misguided Policy. *A Response to Christopher S. Yoo's "Promoting Broadband Through Network Diversity."*

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Network Diversity—A Misguided Policy

A Response to Christopher S. Yoo's "Promoting Broadband Through Network Diversity"

A Policy White Paper Prepared by

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Summary and Overview

Christopher Yoo, a Vanderbilt University law professor, argues in a recent white paper that the regime of open access on which the Internet was founded is actually harmful to innovation, investment, and technology deployment.[1] Professor Yoo supports an alternative to an open Internet, encouraging policymakers to embrace "network diversity." A policy of network diversity would enable last mile-broadband network providers to introduce proprietary network protocols, enter into exclusive agreements with content providers, and discriminate against non-affiliated providers of Internet content, applications, and services.[2] Professor Yoo argues that network diversity will inspire true competition for Internet services, and that this competition can only emerge when multiple last-mile broadband networks are in place.[3]

It is notable that network diversity has already been tried by consumers in the narrow-band dial-up world, and consumers overwhelmingly rejected that approach to the provision of electronic information and communication services. At one time firms like America Online, GEnie, Delphi, Prodigy, and Compuserve offered consumers proprietary data processing and communication services over incompatible and non-interconnected networks. This approach to selling data services ultimately faded as the public Internet became available. Most of the firms

1 Christopher Yoo, "Promoting Broadband Through Network Diversity." Accessed March 1, 2006 at: http://law.vanderbilt.edu/faculty/Yoo%20-%20Network%20Diversity%202-6-06.pdf

Professor Yoo's study, was funded by the National Cable and Telecommunications Association (the principal trade association of the cable television industry in the United States). See, "Law and Technology Professor Releases Study on Net Neutrality," TMCNet News, February 6, 2006. Accessed March 1, 2006 at: http://www.tmcnet.com/usubmit/2006/02/06/1346622.htm

2 Yoo, pp. 6 & 34.

3 Yoo, pp. 5, 15, & 33.

which pursued the network diversity business model no longer exist, and those that do survive have combined Internet access with their proprietary offerings.[4]

Consumers have already voted with their feet away from the proprietary data network model, once given the opportunity to consume electronic data and communication services in an open-access environment. The reason for this exhibited consumer sentiment is the same in the broadband world as it was in the dial-up world—consumers place a high value on services based on policies which encourage protocol standardization, interoperability, and network effects. It is only now, because of telecommunications policy reversals which enable the owners of last-mile broadband facilities to leverage market power in last-mile broadband markets, that the inferior market offering of restricted access to Internet services could be forced on the consuming public.

Professor Yoo suggests that:

> The decision to permit network diversity to emerge does not ultimately depend on the conviction that it would yield a substantively better outcome, but rather from a technological humility that permits exploration to proceed until policymakers can make a clearer assessment of the cost-benefit tradeoff.[5]

However, there is ample evidence that a policy of network diversity will result in a patently inferior outcome which will favor incumbent last-mile broadband providers to the detriment of consumers. These firms currently possess market power in last-mile broadband access networks, and network diversity policy will encourage the leveraging of this market power to higher levels of the Internet.[6] Implementing a policy of network diversity will undermine the vibrant

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4 America Online is the most notable survivor, however, the decline of dial-up access is eroding AOL's customer base. See, "AOL to Pay $1.25 Million Fine," Washington Post, August 25, 2005. Accessed March 1, 2006 at: http://www.washingtonpost.com/wp-dyn/content/article/2005/08/24/AR2005082401989.html

5 Yoo, p. 7.

6 As will be discussed below, most mass-market consumers typically face either
(continued...)

competition and rapid innovation in the provision of Internet content, applications, and services which has characterized the Internet since its privatization in 1995. Professor Yoo argues that this competition need not be protected.[7] If it is not, however, there is no question of harm to consumers.

It is no accident that the network neutrality debate has heated up shortly after the two largest Regional Bell Operating Companies (RBOCs), SBC and Verizon, purchased, respectively, AT&T and MCI. These mergers have combined the last-mile broadband networks owned by SBC and Verizon with two of the largest Internet backbone networks. The resulting combination sets the stage for an attempt to leverage last-mile broadband market power to higher levels of the Internet, a potential for leverage which the Federal Communications Commission acknowledged in its approval of these mergers, through a merger condition requiring adherence to network neutrality principles for a two-year period.[8] However, this short-term protection is not enough.

With regard to the exercise of market power, the RBOCs and cable companies have proven themselves to be anything but "humble." Thus, Professor Yoo's counsel to policy makers that they should offer "humility" and deference to market forces, when those market forces are associated with market power, is bad advice. Given the prospects for last mile competition, ample evidence regarding the RBOCs' and cable operators attitudes toward competition, and the absence of any showing that abandoning network neutrality will *improve*

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[6](...continued)
outright monopoly, or a duopoly, of broadband providers.

[7] Yoo, p. 14.

[8] See, for example: *In the Matter of SBC Communications, Inc. and AT&T Corp. Applications for Approval of Transfer of Control.* WC Docket 05-65, FCC Order No. 05-183, November 17, 2005, Appendix F. Accessed March 1, 2006 at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-183A1.pdf

the lot of consumers, *humility* in the face of market power is a recipe for disaster. The Internet, based on a foundation of open-access principles, was perhaps the greatest innovation of the 20th century. Advocates who prescribe the replacement of open-access principles with a policy of network diversity (which has already been proved inferior to the open-access Internet) should bear a heavy burden of proof. Professor Yoo falls far short of offering the compelling case that is required to dismantle the open-access principles which have promoted competition and consumer benefits.

Organization of this Response

This response is organized into four sections:

- The first section provides an overview of the emerging threat to the open-access Internet, including policy issues which have emerged following the introduction of broadband Internet access technology. Professor Yoo's claim that the network core may be an untapped source of innovation is also evaluated in the first section. This section presents evidence that innovation at the network core will likely be oriented toward increasing last-mile broadband provider revenues, rather than enhancing consumer benefits.
- The second section of this response examines the likelihood of multiple last-mile broadband access facilities emerging, which is the critical article of faith underlying Professor Yoo's argument for network diversity. This section presents evidence that, contrary to Professor Yoo's claims, entry barriers in the provision of last-mile broadband facilities are substantial, and that his vision of multiple "separate but optimized" last-mile networks is not likely to be realized. This section also discusses the fact that, to the extent that they do emerge, last-mile overbuilds are much more likely to occur in high income areas.
- The third section of this response addresses other arguments raised by Professor Yoo

regarding the desirability of a policy of network diversity, including his flawed interpretation of the economics literature relating to vertical integration and standardization.

- The fourth section of this response provides a brief conclusion. Professor Yoo's suggestion that policy makers should have faith that unconstrained firms which possess market power will provide benefits to consumers, and not undermine their competitors, is not supported by his arguments. Humility before firms which exercise market power in markets for last-mile broadband facilities is not good policy.

A Note on Terminology

Professor Yoo identifies a policy of network diversity as one "that regards regulatory forbearance as the appropriate course of action when confronted with ambiguity."[9] However, Professor Yoo also makes it clear that a policy of network diversity would change the way that the Internet operates today. Network Diversity is also consistent with the introduction of proprietary protocols and the ability to exclude, or discriminate against, network applications, content, and services. These changes would reshape the Internet's operations. Thus, my use of the term network diversity should be understood to address both the policy of forbearance and its potential consequences.

The terms "network neutrality" or "open-access Internet," as I use them in this response, should be understood to reflect many of the pro-competitive policies which have been enforced in telecommunications markets in the U.S. The ability of end-users to attach equipment of their choice, the provision of access on nondiscriminatory terms to bottleneck facilities, and the requirement that network providers interconnect are examples of these pro-competitive policies.

9 Yoo, p. 7.

Network neutrality is also consistent with the end-to-end network principles which have been associated with the operations of the Internet. The Internet has operated in a “neutral” environment of open standardization, interconnection, and deference to the network edge, an environment which has generated substantial benefits for consumers, firms, and society.

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I. The Emerging Threat to the Open-Access Internet

How the Internet will evolve in an environment of increasing concentration in telecommunications markets is a critical policy issue. Data processing and communication services first emerged in an environment of structural separation, one where the providers of telecommunications services were prohibited from providing electronic data processing and communication services (now known as "information services") on an integrated basis.[10] In a series of landmark rulings beginning in the late 1960s, the Federal Communications Commission (FCC) determined that the provision of remote computing, information processing, and content-related services by telephone companies was best accomplished by requiring the separation of the providers of information services from the providers of telecommunications services.[11] It is highly likely that this separation of telecommunications and information services contributed to the foundation on which the Internet would develop. By excluding telephone companies from the integrated provision of telecommunications and information services, and requiring that telephone companies provide telecommunications technologies to information service providers on a nondiscriminatory basis, the information service sector, including the Internet, was free to develop under the influence of competitive market forces, without the interference of telephone-company market power.

The Internet, emerging from a government-based research program, adopted principles

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[10] For a discussion of the history of separation of data communication and processing from telecommunications services, see, for example, Huber, et. al., *Federal Telecommunications Law, 2nd ed.* Aspen Publishers, Gaithersburg, NY, 1999. Chapter 11.

[11] These ruling are generally known as the FCC's *Computer Inquiries.* For an overview, please see: Robert Cannon, "The Legacy of the Federal Communications Commission's Computer Inquiries," *Federal Communications Law Journal*, Vol. 55, No. 2, March 2003. Accessed March 1, 2006 at: http://www.law.indiana.edu/fclj/pubs/v55/no2/cannon.pdf

for its operation which were antithetical to the telephone-company network model. Rather than adopting proprietary standards of network operation, the Internet adopted open standards, which have evolved under a regime of open peer review to meet the changing needs of network users. Rather than placing restrictions on the ability of network users to connect equipment and devices to the network, which characterized the telephone-company model of network control, any device which was consistent with the operating protocols of the network could be attached, without centralized control over the actions of those connected at the network edge. As a result of the openness of the Internet, a dramatic engine of innovation was created, with striking improvements in computing and communication the result. The Internet led to entire new industries, and new means for existing industries to operate. Contributing to this very desirable outcome was the inability of firms which held last-mile monopolies in access networks from interfering with the operations of the open-access Internet. Producers and users of Internet services could purchase the telecommunications services which they needed at rates which were regulated by state public utility commissions and the FCC. Thus, the benefits of the information services were available to a wide array of individuals, and the providers of telecommunications services could not interfere with the provision of the information services, either by raising prices for the telecommunications services they sold, or otherwise discriminating against users or providers of information services.

Internet technology initially was utilized in the mass market through dial-up connections over telephone-company facilities. This “narrow-band” access technology was consistent with the development of a highly competitive Internet Service Provider (ISP) market. Thousands of ISPs emerged nationwide, with consumers residing in metropolitan areas having dozens of ISPs to choose from. Market forces led ISPs in the dial-up world to compete on the basis of system availability, quality of service, and access to content. Consumers enjoyed the benefits of competition.

A. The Impact of Broadband Access Technologies

The introduction of broadband access facilities for the mass market by cable television companies immediately created a market rift, as the new access facilities provided a much higher transmission speed, which resulted in vastly improved performance for certain Internet applications, such as web browsing, streaming audio and video, and the transmission of large files (which encouraged file sharing).[12] That the mass-market broadband facilities were offered by cable television companies, rather than regulated telephone companies, resulted in a new approach to the provision of Internet services. As cable companies were ultimately determined to be free from common carrier obligations in their last-mile broadband facilities, vertical integration of the provider of the Internet access facility with the provider of Internet services now became possible, with cable companies free to exclude competing ISPs from the use of their facilities.[13] Telephone companies, while initially required to provide their broadband digital subscriber line (DSL) services to ISPs on a nondiscriminatory basis, also recently gained parity with cable company networks.[14] Competition among multiple ISPs using a broadband connection to the end user provided by a third-party telecommunications provider, as had been the case in the dial-up world, has been ruled out.

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12 Broadband connections had previously only been available through very expensive telephone-company "special access" services, which were typically only affordable for business customers which may have used the facilities to provide Internet services, or for connecting corporate networks to the Internet.

13 *National Cable & Telecommunications Association et al. v. Brand X Internet Services et al.* Supreme Court of the United States, No. 04-277, June 27, 2005.

14 "FCC Eliminates Mandated Sharing Requirement on Incumbent's Wireline Broadband Internet Access Service." FCC News Release, August 5, 2005, announcing FCC Order No. 05-150. http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-260433A1.pdf

The recent mergers of Regional Bell Operating Companies (RBOCs), SBC and Verizon, with two of the largest providers of Internet backbone facilities, AT&T and MCI, have increased the pressure on the open model of the Internet which was the norm in the dial-up access world.[15] The integration of RBOC-controlled broadband access facilities with two of the largest providers of Internet backbone services has led to increased pressure to allow changes in the open-access model of the Internet. Whether broadband access providers should be allowed to bundle Internet services with access services, and exclude third-party ISPs from using the broadband facilities, continues to be one aspect of the open-access debate. However, the scope of the debate is now expanding to whether firms such as the new at&t and Verizon should be allowed to discriminate against third-party providers of Internet content and applications offered by firms such as Google, E-Bay, and Amazon.com. Consumers also have begun to show interest in new Internet services, such as local and long distance telephone calling provided by firms such as Skype and Vonage. Telephone and cable companies view these latter firms as providing a competitive threat to the revenue-generating voice services that they offer, providing a further motivation for the owners of broadband last-mile facilities to discriminate against third-party providers of Internet applications and services.

In a recent interview, the CEO of the new at&t, Edward Whitacre responded as follows to the question “How concerned are you about Internet upstarts like Google (GOOG), MSN, Vonage, and others?”

> How do you think they're going to get to customers? Through a broadband pipe. Cable companies have them. We have them. Now what they would like to do is use my pipes free, but I ain't going to let them do that because we have spent this capital and we have to have a return on it. So there's going to have to be some mechanism for these people

15 Following the merger of SBC and AT&T, the company adopted the name “at&t.” I will use the company’s lower case spelling to distinguish it from the old “AT&T.”

> who use these pipes to pay for the portion they're using. Why should they be allowed to use my pipes?[16]

Other owners of broadband last-mile facilities, such as BellSouth, Verizon, and Comcast have expressed similar sentiments.[17] Thus, the prospect for the owners of broadband access networks (which now also own Internet backbone facilities), to discriminate against the providers of content and services, and to favor content and services provided by the last-mile broadband provider (or its affiliates or strategic partners) is very real. Such an occurrence would result in the potential for the owners of Internet access facilities to leverage their market power into the previously competitive markets for Internet content and applications.

B. Innovation: The Network Core v. The Network Edge

Innovation and investment at the Internet's network edge has provided economic benefits in the U.S.,[18] as the developers of content, applications, software and hardware have been free to introduce new applications, products, and services without the interference of network owners. Much has been written regarding the gains in innovation made possible through the Internet's

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16 At SBC, It's All About "Scale and Scope", BusinessWeek Online, November 7, 2005. Accessed March 1, 2006 at: http://www.businessweek.com/@@n34h*IUQu7KtOwgA/magazine/content/05_45/b3958092.htm

17 "Verizon Executive Calls for End to Google's 'Free Lunch'," *Washington Post*, February 7, 2006, p. D01. Accessed March 1, 2006 at: http://www.washingtonpost.com/wp-dyn/content/article/2006/02/06/AR2006020601624.html

"Phone Companies Set Off A Battle Over Internet Fees," *Wall Street Journal*, January 6, 2006, p. A1. Accessed March 1, 2006 at: http://online.wsj.com/article/SB113651664929039412.html?mod=home_whats_news_us

18 See, for example, Robert E. Litan and Alice M. Rivlin, "Projecting the Economic Impact of the Internet," *American Economic Review*, Vol. 91, No. 2, May 2001, pp. 313-317. See also, Ernest Goss, "The Internet's Contribution to U.S. Productivity Growth," *Business Economics*, October 2001.

basic philosophy of standardized protocols which keep the functioning of the network core from interfering with activity at the network edge.[19] Professor Yoo indicates that this approach is interfering with innovation which may be possible in the network core.[20] Given the track record of network core innovation under the supervision of telephone and cable companies, as compared with the record of network edge innovation associated with the Internet, any advocacy for interference with the innovation process which has emerged at the network edge should undergo significant scrutiny.[21]

Just what sort of innovation at the network core can we expect? Professor Yoo mentions the prospect for specialized networks, as will be discussed further below. However, network equipment manufacturers, the companies that will supply the equipment necessary to manage

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19 See, for example, Carl Shapiro and Hal Varian, *Information Rules,* Harvard Business School Press, Boston, 1999; Jeffrey H. Rohlfs, *Bandwagon Effects,* MIT Press, 2001; Lawrence Lessig, *The Future of Ideas*, Random House, 2001. See also, Jerome H. Saltzer, David P. Reed, David D. Clark, "End-To-End Arguments In System Design" *ACM Transactions on Computer Systems,* (1984). Accessed March 1, 2006 at: http://citeseer.ist.psu.edu/cache/papers/cs/4203/http:zSzzSzweb.mit.eduzSzSaltzerzSzwwwzSzpublicationszSzendtoendzSzendtoend.pdf/saltzer84endtoend.pdf

20 Yoo, p. 21.

21 The pre-divestiture AT&T expended considerable resources attempting to keep network-edge innovators from deploying their innovations. The Carterphone case provided a classic example. Tom Carter developed an acoustical coupling device that provided a means of interconnecting two-way radio systems with the telephone network. AT&T blocked this innovation and sought protection from the FCC. The FCC ultimately agreed to allow the Carterphone to go forward, but also allowed AT&T to require any "foreign" device which was to be attached to AT&T's network to utilize an AT&T-supplied "protective connection arrangement" (PCA). AT&T required the purchase of these PCAs for any end-user who wanted to attach non-AT&T equipment (PBXs, computers, private microwave systems) to AT&T's network. The imposition of additional fees to connect non-AT&T equipment resulted in AT&T "taxing" innovation at its network edge. Taxes on innovation discourage innovation. See, for example, Huber, et. al. *Federal Telecommunications Law, 2nd. ed.* Aspen, 1999, pp. 416-417.

firms like at&t, Verizon, Cox, and Comcast's networks, provide additional insights into the type of "innovation" that we can expect:

> Bundling video with voice and broadband data subscriptions can create a compelling Triple Play offer, with bundles varying from basic to user-centric:
>
> - basic Triple Play offers bundle broadcast TV services with High Speed Internet (HSI) and voice services. This tactical and incremental offer will help operators to reduce churn in the short term;
>
> - user-centric Triple Play, centered around "better TV" (Internet Protocol Television; IPTV), provides the user with a flawless user experience of any content, anytime and anywhere. Added benefits include interactivity, high-definition content, fast zapping time, picture-in-picture, video-on-demand and personalized video recording, providing a much more personal experience. This offer will enable operators to differentiate themselves from their competitors and increase the ARPU of their broadband subscribers.[22]

Thus, "innovation at the core" promises the delivery of "better TV." However, some of the "innovation" promised can already be achieved through other technologies which can be deployed at the network edge. For example, personalized video recording can be achieved by the use of a digital video recorder. Likewise, streaming media can provide video on demand. In light of these potential sources of competition for services which might be offered through "innovation at the core," controlling applications and service providers which might compete with new revenue-generating services becomes imperative for the broadband network provider. Cisco Systems, another equipment provider for the cable and telephone companies which control last-mile broadband networks, offers the following advice regarding the use of its products:

> One of the most significant risks that broadband service providers face is the threat from 'nonfacility' service offerings for music or video downloads, VoIP, or interactive gaming. With the increased bandwidth for high-speed Internet services, operators risk

[22] "Optimizing the network architecture for Triple Play," Alcatel Strategy White Paper, 3rd Quarter 2005, p. 3. "ARPU" abbreviates average revenue per unit. Accessed March 1, 2006 at: http://www.alcatel.com/doctypes/opgrelatedinformation/TriplePlay_wp.pdf

having their service regarded as a baseline commodity as their users subscribe to third-party services from off-net destinations. Examples include:

- Broadband voice services such as Skype, Google-talk, or Vonage that directly compete with a service provider's VoIP service offering.

- Online DVD streaming and download services such as CinemaNOW or RealNetworks SuperPass, which compete for subscription fees of IP-based video services.

Although nonfacility services ride on a best-effort network and may not have the same quality control as the provider's services, for many users the experience is good enough, and nonfacility operators benefit from lower operational expenses and a larger addressable market, making them formidable competitors.

However, broadband service providers can treat nonfacility operators as partners rather than competition. By creating an "open network" environment through which nonfacility operators can ensure adequate customer experience for their application traffic, broadband service providers can open the door for new revenue-sharing schemes. To do this efficiently, a broadband service provider must be able to easily identify the traffic streams of nonfacility services so that it can adequately bill for, audit, and guarantee their performance. The application recognition and granular billing capability of the Cisco Service Control Solution help in the development of these services.[23]

While Cisco's efforts to place the proper spin on the capabilities of their product are amusing, the "open network" world envisioned by Cisco simply empowers the owners of last-mile broadband networks to present third-party content and application providers with an ultimatum—pay-up through our "revenue sharing scheme, or else." The "or else" would be discrimination against the nonfacility sources of applications and content, which is described by Cisco as follows:

The ability of Cisco Service Control to classify and enforce traffic policies. . ., as well as its ability to manage traffic on *an individual user basis*, provides a powerful tool for service providers to manage network traffic through "subscriber-friendly" policies.

Some of the relevant functions include:

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23 "Cisco Service Control: A Guide to Sustained Broadband Profitability," Cisco Systems White Paper, pp. 7-8. While this white paper was accessed by the author on February 16, 2005 on the Cisco website, it has since been removed. It is available at: http://www.democraticmedia.org/PDFs/CiscoBroadbandProfit.pdf

- Classification and identification of all application traffic, regardless of port number or IP address, including support for port-hopping applications (P2P applications such as BitTorrent, eDonkey, or Gnutella), multiflow applications (such as SIP voice over IP or RTSP streaming), and "hidden applications (such as HTTP running on nonstandard port numbers).

- Prioritizing interactive and delay-sensitive applications (such as gaming, voice, streaming, or even Web browsing) at the expense of noninteractive applications (such as P2P file exchange, file downloads, or news transfers), so that preferential treatment can be given to latency-sensitive applications during periods of increased network congestion.

- Establishing "fair-use" policies for customers through usage management algorithms that give every subscriber a fair allocation of available bandwidth—heavy users can no longer take excessive bandwidth and degrade the experience for other subscribers. . .[24]

The "subscriber friendly" set of policies offers the potential for last-mile network providers to identify which sources of content and applications are being utilized by end users, and to allocate bandwidth according to the network operator's revenue generation objectives. If an end-user chooses the wrong content (e.g., content which does not generate revenues for the last-mile network provider), then the network management tools can result in the end user receiving lower priority from the network, or facing bandwidth restrictions. Thus, by controlling how the user receives bandwidth, based on identification and classification of traffic at the individual-user level, the network operator gains the leverage to charge third-party content and application providers for the ability to transmit information over the network so as to ensure that their content and/or applications provide an "adequate customer experience."

Professor Yoo's claim that network neutrality will limit the way network owners can manage their networks[25] ignores the fact that absent network neutrality, network owners will manage their networks not based on the demands of network users, but rather to maximize the

[24] "Cisco Service Control: A Guide to Sustained Broadband Profitability," Cisco Systems White Paper, p. 4, emphasis added.

[25] Yoo, p. 20.

revenue streams which can be extracted from end-users and third-party providers of content, services, and applications. Thus, innovation at the network core will necessarily undermine innovation at the network edge. Providers of last-mile broadband facilities which possess market power will be unlikely to increase bandwidth in response to increased end-user or third-party content providers demands for bandwidth. Rather, the natural and more profitable way to "manage" end users or third-party content providers will be to raise prices for, or otherwise limit the ability to utilize, the bandwidth needed for the successful delivery of content and applications.

Professor Yoo does not make the case that "innovation at the core" will result in expanded benefits for consumers who currently receive benefits from the open-access Internet. Rather, "innovations" would likely (1) push high-end "better TV" services (for a price), (2) result in higher prices for Internet bandwidth utilized to access content, applications, and services which are provided by non-affiliated Internet firms, and (3) increase prices for data usage in general. It is notable that the Cisco whitepaper, cited above, identifies an end-user "service tier" pricing approach associated with the capabilities of its network management equipment. These service-tier pricing plans either specifically limit the end-user to certain types of applications, or charge them more if they pursue certain applications (especially those which might compete with the broadband provider's offerings). Cisco suggests that end users which activate certain types of applications could be charged higher prices on a "pay-as-you-go" scheme, and specifically identifies "streaming, gaming, voice (Skype, SIP)"[26] as targets for higher prices. Clearly, the ability to charge an end-user each time they activate an application which *competes* with offerings similar to those provided by the last-mile broadband provider

[26] "Cisco Service Control: A Guide to Sustained Broadband Profitability," Cisco Systems White Paper, p. 6.

(e.g., video, gaming, and voice) indicates that the biggest "innovation" resulting from the policy of network diversity advocated by Professor Yoo will be higher prices for those who use those Internet applications which provide an alternative to the broadband provider's offerings. These higher prices for use of Internet content, services, and applications will act as a tax on consumption of services provided by third-party sources. This effective taxation will undermine innovation and incentives to invest at the network edge. Innovation at the core thus promises to undermine innovation at the network edge, to the detriment of consumers.

Whether firms that operate in highly concentrated markets for the provision of broadband services should be allowed to leverage their exclusive access to consumers to their further advantage by undermining customer choice in market for Internet services is a critical policy matter.

II. Overview of Professor Yoo's Argument for Network Diversity

Professor Yoo states that a policy of network neutrality focuses on the "the wrong policy problem."[27] Rather than requiring that the owners of broadband access facilities abide by principles of nondiscrimination, which would enable end users to "obtain access to every available applications and piece of information,"[28] Yoo argues that the appropriate focus of broadband policy should be "directed towards identifying and increasing the competitiveness of the last mile, which remains the industry segment that is the most concentrated and protected by entry barriers."[29]

Professor Yoo indicates that a policy of network neutrality has negative consequences which include:

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[27] Yoo, p. 8.

[28] Yoo, p. 53.

[29] Yoo, p. 14.

- A *necessary reduction* in economic welfare due to the standardization of protocols, which he argues reduces product diversity.

- Turning bandwidth into a commodity, which will force broadband access providers to compete solely on the basis of *price and network size*, which will reinforce economies of scale and lead to market failure in last-mile broadband markets.

- The discouragement of investment in new last-mile technologies, resulting in the continuation of highly concentrated last-mile broadband markets.[30]

As will be discussed further below, these criticisms of network neutrality policy are unpersuasive. Professor Yoo misinterprets economic arguments associated with the downside of standardization and offers no evidence that the vast diversity of applications, content, and services which have emerged precisely due to the standardization of Internet protocols would be improved upon by a policy of network diversity. Furthermore, why price competition, an objective which has been pursued for telecommunications markets for the past 25 years, and which has characterized the market for Internet content, applications, and services, should now be viewed as a disadvantage is puzzling, unless one takes the perspective of a last-mile broadband provider hoping to exercise its market power. In addition, he is simply wrong on the matter of network neutrality enforcing an outcome where network size is a point of competition. As will be discussed further below, the size of a provider's network facilities does not matter when networks have the ability to interconnect. Rather, a policy of network diversity, where proprietary and non-standardized protocols may result in network incompatibility, will result in network size being a point of competition.

Importantly, however, while admitting that the last mile is highly concentrated and protected by entry barriers,[31] Professor Yoo does not provide an evaluation of why those entry

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[30] Yoo, p. 15.

[31] Yoo, p. 3.

barriers have been so persistent. The entry barriers which characterize last-mile broadband facilities are very similar to the entry barriers in local telephone markets which were unsuccessfully addressed by the Telecommunications Act of 1996, which attempted to undermine entry barriers in markets for local telephone services. Professor Yoo does not provide any new blueprint which might enable broadband entry, or any evidence that broadband last-mile facilities will not suffer from the same entry barriers that recent history has shown are present in telephone networks. Thus, Professor Yoo ignores the basic problem with the network diversity argument, i.e., why is it reasonable to expect that last-mile competition will emerge?

A. Professor Yoo's Interpretation of Network Economics

Broadband access networks are not provided on a competitive basis today, "the level of production that is most concentrated and protected by barriers to entry is the 'last mile.'"[32] Thus, as network diversity does not exist today in last-mile access markets, it is something that policy makers must strive for through improving the competitiveness of last-mile facilities.[33] What are the entry barriers which might be contributing to the lack of competitiveness? Government franchises may impose an entry barrier, however, it is likely that franchise restrictions are the least problematic entry barrier in last-mile broadband markets, and Professor Yoo does not discuss government franchises as a policy problem.[34] If government franchise is not the

32 Yoo, p. 3.

33 *Id.*

34 Government franchise restrictions may inhibit the deployment of television services. These restrictions are being addressed by state and federal legislators and may be addressed by the FCC. See, for example, "Perry Signs Telecommunications Reform Bill," Press release issued by Texas Governor Rick Perry, September 7, 2005. Accessed March 1, 2006 at: http://www.governor.state.tx.us/divisions/press/pressreleases/PressRelease.2005-09-07.1706

(continued...)

problem, there must be economic reasons for the noncompetitive state of the broadband access market. Economists have identified certain factors which make market entry less likely.[35] For last-mile broadband facilities, these factors can include:

- Economies of scale—due to high fixed costs, unit costs of operation will decline as the size of the broadband access network increases. As small firms face an absolute cost disadvantage, economies of scale can contribute to an entry barrier.

- Economies of scope—multiple services can be offered over broadband access networks, resulting in declining unit costs as the number of services offered over the network increases. Firms which cannot offer a full range of services face a cost disadvantage, thus economies of scope can contribute to an entry barrier.

- Economies of density—higher customer density will result in lower unit costs. Economies of density may result in a greater potential for broadband deployment in urban areas, and less potential for entry in suburban and rural areas.

- Sunk costs—sunk costs are not recoverable once incurred. When sunk costs are present, entry risks are much higher as costs are non-recoverable. Sunk costs are associated with last-mile broadband facilities and can result in an entry barrier.

- Network effects—the more content, services, applications, and other users who are accessible on a network, the more valuable the network (and broadband connection becomes). Absent network interconnection and nondiscriminatory treatment of network traffic, network effects can contribute to an entry barrier.

Professor Yoo addresses only two of these factors which may make entry in the market for last-mile broadband less likely (economies of scale and network effects), and his treatment of these factors is anything but satisfactory.

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[34](...continued)
See also, “Key Lawmakers Craft Narrow Video Franchising Measures,” National Journal’s Telecom Update, February 24, 2005. Accessed March 1, 2006 at: http://www.njtelecomupdate.com/lenya/telco/live/tb-JDUQ1141059801909.html

and, “FCC Chief Considers Forcing Cable TV Competition,” *USA Today,* August 22, 2005. Accessed March 1, 2006 at: http://www.usatoday.com/money/industries/telecom/2005-08-22-telecom-usat_x.htm

[35] See, for example, Jean Tirole, *The Theory of Industrial Organization*, MIT Press, 1989, Chapter 8 and *passim.*

1. Professor Yoo on Economies of Scale

Economies of scale contribute to entry barriers, as large-scale operations result in low unit-costs. If economies of scale are pronounced, a small-scale entrant will face an absolute cost disadvantage, and will not be able to survive price competition with the incumbent.[36] Alternatively, firms contemplating large-scale entry where incumbent facilities are already deployed face the prospect of flooding the market with output, which reduces the expectations of generating sufficient revenues to ensure profitability.[37] In the context of last-mile broadband access markets, incumbent cable and telephone companies with existing last-mile facilities enjoy economies of scale.

Do scale economies contribute to an entry barrier in last-mile broadband markets? Professor Yoo indicates that through a process of “network differentiation,” such as that which might occur through “protocol nonstandardization,” small-scale last-mile providers can profitably exist alongside incumbent providers which enjoy a high level of scale economies.[38] Under a system of non-standardized protocols, Professor Yoo argues that services of greater value could be offered to consumers who placed high values on the characteristics of the non-

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[36] The FCC, acting on the guidance of Congress, determined that the sharing of scale and scope economies present in last-mile facilities was a critical objective of the implementation of the Telecommunications Act of 1996. See, for example: *In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996 Interconnection between Local Exchange Carriers and Commercial Mobile Radio Service Providers,* CC Docket Nos. 96-98 & No. 95-185, FCC 96-325, First Report and Order, August 8, 1996, ¶232.

[37] With regard to last-mile facilities, “flooding the market” is reflected in expected “take-rates,” the percentage of homes passed expected to sign-up for service. If multiple last-mile broadband providers serve a single market area, lower take-rates are expected as several firms attempt to serve each customer.

[38] Yoo, p. 25.

standardized services.[39] The higher values associated with these non-standardized services could thus support a separate network, even though scale economies might not be fully exploited. As will be discussed below, Professor Yoo's vision for small-scale entry is highly problematic.

The small-scale networks are described by Professor Yoo as follows:

> . . . network diversity might make it possible for three different types of last-mile networks to coexist: one optimized for traditional Internet applications such as e-mail and website access; another incorporating security features to facilitate e-commerce and to guard against viruses, spam, and other undesirable aspects of life on the Internet; and a third that prioritizes packets in the manner needed to facilitate time-sensitive applications such as streaming media and VoIP. Each would survive by catering to the market subsegment that places the highest value on a particular type of service.[40]

The network diversity described by Professor Yoo might contribute to an increase in some consumers' valuation of the non-standardized services, however, there is also a value degradation as integrated services are not provided over these small-scale networks. Consumers have exhibited strong preferences for the use of integrated services over the Internet, even if those services are less than optimal. For example, Internet voice services provided by applications like Skype are of less than optimal quality. The Internet may introduce delay, which degrades the quality of voice communications. However, given that over 260 million Skype downloads have occurred,[41] numerous Internet users must like the integrated function and low price offered by use of the application, even if its performance is less than optimal.

Professor Yoo fails to consider the net impact of his "separate but optimized" networks on consumer choice. Consumers will evaluate the overall impact on their network experience resulting from the availability of an alternative, "optimized," network providing non-

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39 *Id.*

40 Yoo, p. 5.

41 Skype web site. Accessed March 1, 2006 at: http://share.skype.com/facts_and_figures/tools_for_sharing/facts_%26_figures/

standardized services. Any gains in consumer satisfaction from the non-standardized services will be weighed against the higher price for the service,[42] and the losses in consumer satisfaction resulting from the degradation in interoperability and network effects which result from "optimization" of the alternative network. Consumer recognition of the downside of non-standardized network services, even if they are optimized, undermines the market feasibility of the non-standardized services.

a. "Separate But Optimized" Undermines Investment Incentives

Ironically, Professor Yoo's vision of "separate but optimized" small-scale last-mile data networks would undermine the very incentives to invest in alternative broadband networks which are critical to the network diversity argument. The three separate networks described by Professor Yoo, according to his vision of network diversity, are not delivered over shared facilities (the sharing of broadband access facilities and the ability to capture economies of scope is, in Professor Yoo's view, an undesirable outcome). Rather, separate last-mile broadband facilities would deliver each type of network. Thus, not only must separate last-mile broadband networks be built, but they will be built to provide unintegrated (and therefore lower value) network services. Under such a scenario, the business case for separate broadband networks suffers. The existence of "separate but optimized" data networks undermines the investment incentives which are critical to the network diversity argument.

Professor Yoo provides additional information which rebuts his own argument regarding the allegedly diminishing role of scale economies as an entry barrier in last-mile broadband facilities. Professor Yoo discusses the relationship between last-mile broadband transmission facilities and the "pre-last-mile" packet transmission network, noting that:

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[42] Professor Yoo (p. 24) acknowledges that the "separate but optimized" networks must charge higher prices to recover their higher costs.

> Both DSL and cable modem providers must maintain equipment, either a DSL access multiplexer (DSLAM) or a cable modem termination system (CMTS) to separate the stream of data packets from other types of communication. In this environment, last-mile providers no longer serve as mere pass-throughs. Instead, they must necessarily maintain a data network to hold the packet-switched traffic once it has been segregated from the other traffic. They must also negotiate some type of interconnection agreement with another carrier so that this traffic can be routed to its final destination.[43]

When evaluating Time Warner, which, due to merger conditions imposed as a result of the Federal Trade Commission's review of the AOL/Time Warner merger, is the only last-mile broadband provider which has been required to offer multiple ISPs the ability to utilize broadband access facilities on a nondiscriminatory basis, Professor Yoo notes:

> Contrary to the original expectations of the FTC, the unaffiliated ISPs that have obtained access to Timer Warner's cable modem systems have not created their own packet networks within Time Warner's cable headends. Instead, traffic bound for these unaffiliated ISPs exit the headend via Time Warner's backbone and is handed off to the unaffiliated ISP at an external location. The fact that these unaffiliated ISPs have found it more economical to share Timer Warner's existing ISP facilities rather than build their own strongly suggests that integrating ISP and last-mile operations does in fact yield real efficiencies.[44]

If the efficiencies of sharing which Professor Yoo identifies do exist, this suggests that the prospects for last-mile competition are not promising. If independent ISPs have not been able to satisfy a business case to build packet networks within cable companies headends, then why is it a reasonable expectation that these same firms will overbuild the entire last-mile network? If the economies identified by Professor Yoo can only be captured by integrating last-mile and pre-last-mile facilities, then these economies of scale are only available to those making substantial sunk investments. The investment associated with a last-mile overbuild dwarfs the investment necessary to construct "pre-last-mile" facilities within a headend, and the scale economies and sunk costs associated with building a separate last-mile broadband access network results in an

43 Yoo, p. 37.

44 Yoo, pp. 37-38. FTC abbreviates Federal Trade Commission, which imposed conditions on the AOL Time Warner merger.

entry barrier which is not likely to be eliminated in the near future.

b. Last-Mile Competition for Whom?

Professor Yoo's vision of network diversity rests on smaller-scale entrants delivering higher value services, which also have higher costs and higher prices.[45] To implement the business plan suggested by Professor Yoo, one would expect that the alternative last-mile provider would need to target those who would both assign higher values to the services, and who could also act upon their higher values for the non-standardized service by paying higher prices, i.e., those with discretionary incomes sufficient to afford the higher-priced services. The experience of the cable television market provides some lessons regarding where alternative facilities are more likely to be deployed. Some cable overbuilders have emerged, which construct alternative facilities and offer a variety of services over their networks—voice, video, and broadband Internet access. As might be expected, cable overbuilders target wealthy communities, where expected revenues are higher.[46] There is no reason to expect that a different outcome would be associated with the policy of network diversity. Thus, abandoning principles of network neutrality must be viewed in light of the potential that multiple sources of broadband last-mile facilities might only emerge in areas where consumer incomes are higher. Elimination of network neutrality principles will leave those consumers residing in areas which are less likely to be attractive to broadband overbuilders reliant on a much more limited (possibly monopoly) source of broadband supply. Given the impact of the abandonment of network neutrality principles on the supply of Internet content, services, and applications, consumers

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[45] Yoo, p. 24.

[46] "Small but Powerful," *Broadcasting & Cable,* July 18, 2005. Accessed March 1, 2006 at: http://www.broadcastingcable.com/article/CA626058.html?display=Special+Report

residing in areas which do not attract multiple sources of last-mile broadband supply will face a highly inferior service, and have very limited ability to seek alternatives.

In summary, Professor Yoo's claims that scale economies are unimportant and do not present an entry barrier are unreasonable. His claims that a policy which abandons principles of network neutrality will spur the deployment of multiple broadband last-mile facilities must be viewed with great skepticism. Economies of scale continue to characterize last-mile broadband access markets. If potential overbuilding firms cannot achieve the scale economies associated with incumbent broadband provider networks, these overbuilders must expect to charge higher prices. A reasonable expectation, then, is that higher income areas will be a more likely target for any overbuilding which might occur. A policy that abandons network neutrality with the hope that new incentives will be provided for investment in multiple last-mile broadband facilities is based on a very doubtful foundation and will likely result in most consumers facing a highly concentrated (monopoly or duopoly) market for broadband access, and which allows the leverage of market power from the access market to Internet content, applications, and services.

2. Professor Yoo on Network Effects

Professor Yoo also points to demand-side scale economies, or economic network effects, as contributing to concentration in telecommunications networks.[47] Network effects exist when the value of a product or service increases as more individuals utilize the product or service. The telephone network provides a classic example: If you are the only subscriber to the network, telephone service offers little value; networks which enable communication with larger numbers of users exhibit much greater value to consumers. The substantial network effects associated with the Internet are a result of the standardization of network protocols, and policies which

[47] Yoo, p. 27.

encourage network interconnection.

Professor Yoo's focus on demand-side economies of scale as a source of entry barriers under current market conditions is entirely misplaced. He ignores the fact that the policies which have required network interconnection have eliminated demand-side economies of scale as an entry barrier. If networks are required to interconnect, then no network owner has an advantage based on the size of its network. Demand-side economies of scale only become an entry barrier through the absence of network interconnection, thus enabling a network owner's attempts to leverage the size of their network to the detriment of competition and consumers. For example, in the early part of the 20th Century, AT&T leveraged its nationwide system of long-distance lines to the detriment of smaller independent telephone companies.[48]

However, Professor Yoo argues that "differentiation can ameliorate the demand-side economies of scale created by network economic effects. If the smaller network is optimized for particular functions that a particular group of end users values particularly highly, those end users may be willing to join the smaller network notwithstanding the presence of network economic effects."[49] He goes on to state:

> Mandating the use of standardized protocols and prohibiting content exclusivity threatens to commodify bandwidth and force providers to compete solely on the basis of *price and network size*, which would in turn reinforce the advantages enjoyed by the largest players.[50]

While competition on the basis of price might be viewed as an undesirable outcome to firms which are not used to facing price competition, it is not at all clear why competition based on price should be ruled out as a policy objective. However, Professor Yoo's reference to the

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48 Faulhaber, Gerald. *Telecommunications in Turmoil,* Ballinger Publishing, Cambridge, MA, 1987. See especially, Chapter 1.

49 Yoo, p. 28.

50 Yoo, p. 28, emphasis added.

need to compete based on "network size" is simply wrong. As discussed above, competition based on network size only occurs in the non-standardized, non-interconnected "network diversity world" which Professor Yoo advocates. Under network neutrality policy, which is currently the case in voice telephone networks, where all providers of telecommunications services must interconnect by law, and in the current market for Internet services, where ISPs have interconnection points of last resort at NAPs, network size is not a point of competition.

Due to network neutrality policies, as all networks interconnect and use the same protocols, *the network is the same size for all.* The policy advocated by Professor Yoo would potentially introduce the undesirable market outcome which he wrongly attributes to the policy of network neutrality. Should a policy of network diversity be pursued, only then would those firms with the largest number of subscribers gain market advantage, as they would control the largest number of users and offer the largest network value. Thus, the policy of network diversity sows the seeds of increased market concentration in the last-mile, as consumers would naturally gravitate to the network with the largest number of subscribers as it would offer the highest value, even if the value offered by "network diversity" is lower than that available in the interconnected, standardized, open-access world of today.

a. Consumers Have Already Rejected the Network Diversity Model

The Internet, operating under a regime of standardized protocols and interoperability, has resulted in expansive consumer benefits. Standardization is widely recognized to be beneficial to consumers, as it reduces purchase risks and expands network effects, which increase product values.[51] It is also recognized that standardization may result in some reduction in variety, which suggests that any conclusions regarding whether consumers benefit more from standardization,

[51] See, for example, Carl Shapiro and Hal Varian, *Information Rules*, Harvard Business School Press, Boston, 1999, p. 233.

or from the elimination of standardization, will be a “net benefit” analysis. The standardization associated with the Internet operates at a “wholesale level.” The standardized network protocols reside in logical network layers below the “application level,” which is associated with the Internet products used by consumers. Thus, due to the standardization of Internet protocols, consumers are presented with a wide variety of content, applications, and services, all of which are interoperable. Due to the standardization of Internet protocols at the wholesale level, consumers enjoy differentiated retail products, and are able to benefit from network effects and the advantages of interoperability. The standardization allows the rise of niche market providers, which can tailor their Internet services to the needs of individuals, again adding to consumer benefits.[52]

History provides a laboratory for the evaluation of consumer reactions to standardization in information networks, i.e., whether any losses in variety associated with standardization are outweighed by the gains from compatibility, interoperability, and network effects. Consumers have had the opportunity to experience electronic information services operating on non-standardized platforms. Prior to the commercialization of the Internet, online service providers such as America Online, GEnie, Compuserve, Prodigy, and Delphi offered consumers the ability to utilize chat and bulletin boards, access electronic news and information, and send e-mail. However, these systems were not interconnected, and users of one online service generally could not communicate with the subscribers of other online service providers.[53] These proprietary network service providers were, of course, free to innovate in their “network cores.” However, the commercialization of the Internet, with its open and non-proprietary standards, provides an object lesson in what consumers have deemed the superior approach—i.e., innovation at the

52 *Id.*, p. 187.

53 *Id.*

network edge. Once the expansive network effects and interoperability benefits associated with the Internet became freely available to any entity which abided by the principles of the open-access Internet, the proprietary network model quickly withered. The proprietary services which were offered by online service providers were judged by consumers as inferior to the content, applications, and services, operating under the regime of standardized Internet protocols, which were competitively available over the Internet.

b. Leverage of Last-Mile Network Effects

Of course, given the opportunity, it may be more profitable for a business to try to leverage network effects to its advantage. A recent dispute between two Internet backbone providers, Level 3 Communications and Cogent Communications, shows that restrictions on preferential interconnection through private peering arrangements has the potential to disadvantage an ISP. In this dispute Level 3 terminated a private peering arrangement between its network and Cogent's network, resulting in temporarily restricted availability of Internet services to Cogent's customers. Level 3, which has a larger backbone network than does Cogent, had the ability to disadvantage the smaller Cogent Communications through refusal to continue interconnection through peering, however, the availability of interconnection of last resort facilities at NAPs, and the availability of other private peering arrangements, allowed Cogent to continue its operations through alternative interconnection arrangements.[54] Unfortunately, these alternatives do not exist for last-mile facilities.

AOL's attempt to prevent members of its subscription-based online service from using Instant Messaging (IM) to communicate with other IM users outside of AOL's network provides

[54] See, *News.com*. "Network Outage Fixed, For Now," October 7, 2005. Accessed March 1, 2006 at: http://news.com.com/Net+backbone+outage+fixed,+for+now/2100-1036_3-5891274.html

another example.[55] AOL's decision to block communication from instant messaging platforms outside of its system undermined the value of the IM technology to all IM users, however, AOL, having a large number of IM users, believed that it could benefit by denying interconnection of its IM application with competing IM applications.[56]

Until relatively recently, no owner of last-mile Internet access facilities was able to contemplate leveraging demand-side economies of scale associated with the Internet. Because these last-mile facilities have been provided on a neutral basis, the increase in network value resulting from the vastly expanded communication capability enabled by the Internet benefitted consumers. However, the network diversity argument which Professor Yoo supports, complete with incompatible networks and proprietary protocols, has the potential to result in the largest integrated providers, firms like Verizon, the new at&t, and cable operators like Comcast and Cox, leveraging network effects to the detriment of consumers and competition in the provision of Internet content, applications, and services.

Internet network neutrality and network interconnection has led to the elimination of entry barriers associated with network effects and has resulted in the dramatic creation of value,

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55 See, for example: "AOL blocks AT&T instant messaging," CNN.com, December 9, 1999. Accessed March 1, 2006 at: http://transcripts.cnn.com/1999/TECH/computing/12/09/aol.att.idg/index.html

See also, "AOL blocks messaging rival," *InfoWorld,* June 12, 2000. Accessed March 1, 2006 at: http://www.infoworld.com/articles/hn/xml/00/06/12/000612hnmessage.html

56 AOL's activities regarding IM services were ultimately constrained by merger conditions imposed as a result of the AOL/Time Warner merger. See, for example: *In the Matter of Applications for Consent to the Transfer of Control of Licenses and Section 214 Authorizations by Time Warner Inc. And America Online, Inc., Transferors, to AOL Timer Warner Inc., Transferee,* CS Docket No. 00-30, Memorandum Opinion and Order, FCC Order 01-12, January 22, 2001, ¶325. Accessed March 1, 2006 at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-01-12A1.pdf

both commercially and as a means to freely exchange information.[57] On the demand side, the ability of Internet users to run the applications of their choice, access the content of their choice, and communicate with all other Internet users provides significant network value. On the supply side, the open standardized platform associated with Internet protocols provides a substantial investment incentive for application, content, and service developers. If a new application is based on Internet protocols, the developer knows that the widest possible market will be capable of utilizing the new application, and the potential market rewards will reflect this network effect.

In summary, Professor Yoo's treatment of network effects reveals a major shortcoming of the "network diversity" argument. Under existing arrangements, the interoperability and standardization generated by the principles of network neutrality generate substantial values for consumers. The value of network effects to consumers are placed at risk through the policy of network diversity. As the network diversity policy has the potential to undermine network effects, advocates for this position should be able to provide substantial evidence of the tangible benefits that de-standardization and closed access are purported to generate. Professor Yoo provides no such information.

B. Prospects for Multiple Broadband Access Technologies

Professor Yoo fails to make a convincing case that economies of scale do not continue to present an entry barrier in last-mile broadband markets. Furthermore, he overlooks the important role of sunk costs in deterring facilities-based last-mile broadband entry. As he indicates that "the primary focus of broadband policy should be on fostering greater competition

57 See, for example, Jeffrey H. Rohlfs, *Bandwagon Effects*, MIT Press, 2001, pp. 191-192.

in the last mile . . . .",[58] a logical step in determining the prospects for competition in the last mile is to evaluate current and reasonably anticipated last-mile broadband access technologies, and how those technologies might be expected to compete, and whether competition will be sustainable.

Lessons available from other segments of the telecommunications market leads to the conclusion that there has been little luck in sustaining competition for last-mile facilities. For example, following the implementation of the Telecommunications Act of 1996, which eliminated legal entry barriers in the local exchange market, competitive local exchange carriers (CLECs) emerged and began to construct new last mile-facilities, primarily in the core business districts of urban areas, targeting large business customers.[59] These independent alternative last-mile facilities have not proved durable. For example, two of the largest facilities-based CLECs, Teleport and MFS, were acquired by other, larger, CLECs (AT&T and MCI)[60] in the late 1990s.[61] AT&T and MCI expanded their facilities and competed for a time against incumbent local exchange carriers using these last-mile assets, however, this facilities-based last-mile competition was not sustainable. Now the assets of the formerly independent CLECs AT&T and MCI have been acquired by the incumbent carriers SBC (which now operates using the "at&t"

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58 Yoo, p. 14.

59 See, for example, Richard G. Tomlinson, *Tele-Revolution*, Penobscot Press, 2000, Chapter 10.

60 MFS was acquired by WorldCom, which later acquired MCI and began operating under the MCI brand name.

61 "AT&T, SBC To Buy Carriers," *Information Week*, January 12, 1998. Accessed March 1, 2006 at: http://www.informationweek.com/664/64iuatt.htm

"WorldCom becoming one-stop provider," Cnet News, September 8, 1997. Accessed March 1, 2006 at: http://news.com.com/WorldCom+becoming+one-stop+provider/2100-1001_3-203013.html name) and Verizon.[62] Very few facilities-based CLECs survive today. Thus, the last-mile competition that was envisioned under the Telecommunications Act has not proved to be enduring.

Similarly, with regard to wireless telephony, initial arrangements provided two cellular licenses in each market area, with the incumbent telephone company given the right of first refusal for one of the licenses, an arrangement which frequently resulted in the cellular carrier affiliated with the incumbent "competing" against an independent wireless provider. Of course, the "competition" under the cellular duopoly arrangements resulted in high prices and poor service quality, and low take-rates for the service. Spectrum reallocation and the new policy of FCC auctions resulted in increased wireless competition, with numerous licenses becoming available in any specific market area.[63] This last-mile voice wireless competition is also proving to be less than durable. Due to the FCC's elimination of restrictions on the amount of spectrum that can be controlled by a firm in a specific market area, major mergers of wireless firms have occurred. AT&T (the long distance provider and CLEC) spun off its wireless operations in 2001. AT&T wireless was then acquired by Cingular Wireless (jointly owned by the RBOCs SBC and BellSouth) in 2004. Voicestream wireless merged with Omnipoint Communications and Aerial Communications in 2000. Voicestream was later acquired by Deutsche Telecom and now operates under the T-Mobile name. In 2005 Sprint combined its wireless operations with

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62 Divestiture of some last-mile "special access" connections was required as conditions placed by the Department of Justice on these mergers. See, "Justice Department Requires Divestitures in Verizon's Acquisition of MCI and SBC's Acquisition of AT&T," October 27, 2005. Accessed March 1, 2006 at: http://www.usdoj.gov/opa/pr/2005/October/05_at_571.html

63 For detailed data, see: http://wireless.fcc.gov/services/index.htm?job=data&id=broadband_pcs and, http://wireless.fcc.gov/services/index.htm?job=data&id=cellular

the wireless operations of Nextel. Also in 2005, Western Wireless was acquired by the wireless and local exchange operator Alltel. This consolidation in the wireless industry points to an emerging oligopoly market in wireless, with the two largest wireless firms (Cingular and Verizon Wireless) being owned by three of the four remaining RBOCs. Thus, last-mile consolidation is evident in the wireless segment as well.

1. Alternative Broadband Pathways

The network diversity policy advocated by Professor Yoo critically depends on a competitive market for last-mile broadband facilities. For last-mile residential broadband markets to stray from today's monopoly or duopoly structure, there should be numerous alternative broadband networks. It is difficult to imagine competitive forces functioning with two or three last-mile providers, and certainly not with one.

According to the most recent data available from the FCC, as of December 31, 2004, there were approximately 38 million high-speed connections in the U.S.[64] These lines were provided predominantly over telephone company DSL, and cable television company "cable modem" facilities, which respectively provided 36% and 57% of all high-speed lines. The FCC reports that "other wireline" connections (e.g., fiber to the home) provided 4% of all high-speed connections, and that "other" technologies (e.g., fixed wireless, satellite), provided 3% of all high-speed connections. Thus, the current state of the last mile is one where, nationally, two technologies dominate—DSL and cable modem.

Given this starting point, what are the prospects for diverse and competitive sources of supply on which the network diversity arguments hinge? In addition to DSL and cable modem facilities, prospective last-mile broadband facilities include two proven technologies, fiber optic

[64] The FCC classifies "high-speed" connections as those providing transmission speeds of 200 kbps or higher in at least one direction.

cable and wireless, one emerging technology, broadband over power lines (BPL), and one conceptional technology, broadband in gas (BIG). It is instructive to evaluate the potential of these alternatives.[65]

a. Fiber Optic Cable

Fiber optic cable is capable of delivering almost unlimited bandwidth to the end user.[66] Once the cables are put in place, which is a costly process that involves substantial fixed and sunk costs, the capacity of the cable may be increased as the technology that lights the fiber improves, new electronic devices can be placed on the cable ends, and the capacity of the cable expands accordingly. Once a customer is served by fiber cable, all non-mobile communications services could be provided over the single fiber pathway: voice, super-high-speed data, and HDTV quality video. Once fiber is put in place by one provider, the business case for additional high-speed last-mile facilities weakens. This fact is readily discernable by efforts of incumbents to block fiber-to-the-home projects which have been pursued by municipalities. Both incumbent telephone companies and incumbent cable operators have taken steps to disable the attempts of municipalities to deploy fiber.[67] Thus, fiber optic cable, either connected directly to the

[65] It is also possible that broadband services may be delivered by satellite. However, satellite bandwidth is highly limited on a national basis (there are only so many satellite orbital slots and transponders available), thus it is likely that satellite broadband will likely continue to be a high-priced niche-market alternative which provides services where other facilities have not been deployed, i.e., rural and insular areas. Given these limitations, I don't believe that satellite deserves consideration as a mass-market alternative

[66] International Engineering Consortium, "Fiber to the Home Tutorial," p. 3. Accessed March 1, 2006 at: http://www.iec.org/online/tutorials/acrobat/fiber_home.pdf

[67] See, for example: "High-Speed SONET to Your Illinois Door? SBC, Comcast Say No," December 17, 2003. Accessed March 1, 2006 at: http://www.tricitybroadband.com/news18.htm

(continued...)

household, or terminated near the house (and using existing metallic cable distribution to bridge the last few hundred feet), will provide a virtually unlimited supply of bandwidth to any end-user. Once fiber is deployed, its vast capacity will undermine the attractiveness of other technologies which are not capable of delivering the extremely high bandwidth (e.g., 100 Mbps) which fiber is capable of delivering to end users.

It is simply not reasonable to believe that capital markets will support numerous last-mile fiber overbuilds. For example, the feasibility study for one public fiber deployment project, Utah's "UTOPIA" network, found that municipal networks have an average take rate of 56% after six years, and that private overbuilder networks (primarily cable television overbuilds) have exhibited average take rates of 45% after four years.[68] The multiple last-mile networks envisioned by Professor Yoo would imply average take-rates at much lower levels than those currently observed for overbuilders.[69] As is noted in the UTOPIA feasibility study, increased competition leads to lower take rates, increased costs associated with churn, and declining revenues.[70] This market reality would work against the business case for multiple fiber overbuilds.

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[67](...continued)
"Lafayette hits snag in fiber build," CNet News, February 24, 2005. Accessed March 1, 2006 at: http://news.com.com/Lafayette+hits+snag+in+fiber+build/2100-1034_3-5589315.html?tag=nl

[68] UTOPIA Feasibility Assessment, Dean & Company, May 13, 2004, p. 5. Accessed March 1, 2006 at: http://www.utopianet.org/downloads/dean_report.pdf

[69] To date, cable overbuilders have competed primarily against incumbent cable companies. The UTOPIA project provides wholesale network access—third-party providers will use UTOPIA's bandwidth to deliver retail services (voice, video, and data), and compensate UTOPIA at wholesale rates. See UTOPIA business case, accessed March 1, 2006 at: http://www.utopianet.org/business_case/revenues.htm

[70] *Id.*, pp. 25-26.

b. Fixed Wireless Networks

Fixed wireless last-mile broadband networks have the potential to reduce fixed and sunk costs which are associated with the deployment of fiber last-mile networks. However, wireless networks face limitations due to the inferior wireless spectrum which has been made available by the FCC for these networks. Spectrum (radio frequency) is a finite resource—using current technologies there is only so much spectrum to go around. Furthermore, spectrum is not of uniform quality. Higher frequency radio waves are more likely to suffer from interference from objects such as buildings, rain and snow, and foliage. While higher frequencies can deliver high-quality transmission capacity, they are more likely to require a direct line of sight between points of transmission.[71] Constructing line-of-sight wireless networks may be useful for network transport, but it is much more costly to install as a last-mile facility. Unfortunately, the spectrum which has been allocated for new applications, such as the WiMax service identified by Professor Yoo,[72] operates in high frequency ranges, requiring line-of-sight transmission to achieve the highest bandwidth. The very high frequencies in which WiMax operates, ranging between 2GHz and 11GHz for the non-line of sight service, and up to 66GHz for the highest-speed line-of-sight transmission, indicates that the spectrum is not optimal for last-mile facilities.

With a WiMax deployment, the overall amount of bandwidth available in a cell site is shared among multiple users, which diminishes transmission speeds available for any individual user. While the technology is capable of providing up to 70 Mbps of transmission speed, this capacity is shared among multiple users, which considerably reduces transmission capability for any individual user. Existing WiMax providers are marketing services at speeds comparable to

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[71] See, for example, George Abe, *Residential Broadband*, Cisco Press, 2000, p. 87.

[72] Yoo, p. 25.

existing DSL.[73]

As noted by former FCC Chairman Reed Hundt, better spectrum is assigned for use in delivering television service (both analog and digital). Hundt concludes:

> "The current chapter in this ongoing story of facilitating the creative innovation of capitalism will be written if Congress and the FCC can find ways to let businesses use the best spectrum physics, not for UHF television, but rather for wireless broadband."[74]

Unfortunately, as evidenced by the high frequencies utilized by WiMax, the promise of wireless broadband last-mile facilities may be undermined by the unavailability of adequate spectrum. Also working against last-mile wireless networks is the fact that incumbents have also been very active in efforts to block municipal wireless last-mile projects.[75]

c. Broadband Over Power Lines

Professor Yoo also mentions broadband over power lines (BPL) as a potential alternative last-mile facility. BPL technology is currently in the trial phase, but problems have emerged with this technology, especially with the generation of external interference which affects radio transmission. As is noted by one observer:

> Power lines are designed to carry electrical power. They were not designed to carry radio signals. They do this very poorly . . . radiating them as radio signals that can and do affect nearby receivers using those frequencies. Amateur radio operators, CB operators

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73 "Wimax Just One Part Of The Telecom Future, Execs Say," Cox News Service, October 30, 2005. Accessed March 1, 2006 at: http://www.coxwashington.com/reporters/content/reporters/stories/BC_TELECOM_ADV30_COX.html

See also, Clearwire Wireless Broadband Plans. Accessed March 1, 2006 at: http://www.clearwire.com/store/service_plans.php

74 "Wireless Broadband Said To Use Wrong Spectrum," intenetnews.com, April 29, 2004. Accessed March 1, 2006 at: www.internetnews.com/wireless/article.php/3347021

75 "Pennsylvania Governor Signs Wi-Fi Bill," e-Week.com, December 6, 2004. Accessed March 1, 2006 at: http://www.eweek.com/article2/0,1895,1735342,00.asp

> and shortwave listeners are all found commonly in the residential neighborhoods where BPL will be installed. They will all suffer strong interference if BPL uses their frequencies at the permitted levels.[76]

The generation of radio interference has been an unresolved issue in several BPL trials, and led to the termination of at least one trial.[77] Despite interference problems, which have yet to be resolved by the FCC, BPL may offer some promise as an alternative last-mile facility, although current transmission speeds from BPL (2Mbps to 6Mbps) are much lower than those available from fiber optics.[78] Furthermore, BPL will face a market where incumbents have already gained first-mover advantage by deploying fiber. As was recently noted by one analyst: "By the time it (BPL) really arrives in the market, terrestrial broadband will be almost fully saturated."[79]

d. Broadband in Gas?

In addition to these alternatives, a conceptual last-mile technology is broadband in gas (BIG). The BIG technology envisions a system where ultra wideband radio waves are transmitted within existing gas distribution plant, with the gas pipes acting as wave guides.[80] The technology has yet to be subject to commercial trials, although some laboratory trials have

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[76] "Frequently Asked Questions about BPL," Anthony Good. Accessed March 1, 2006 at: http://www.qrpis.org/~k3ng/bpl.html

[77] "BPL Trial Shelved," *BroadbandReports.com*, June 29, 2004. Accessed March 1, 2006 at: http://www.dslreports.com/shownews/46964

[78] "BPL Growing More Popular," *America's Network*, October 1, 2005. Accessed March 1, 2006 at: http://www.americasnetwork.com/americasnetwork/article/articleDetail.jsp?id=188591

[79] Ken Kerschbaumer, "Plug-and-Play Internet Wall-outlet broadband attracts heavy hitters," *Broadcasting & Cable*, 7/18/2005. Accessed March 1, 2006 at: http://www.broadcastingcable.com/article/CA626059.html?display=Technology

[80] The company behind BIG is a start-up based in Escondido, California called Nethercomm. See: http://www.nethercomm.com/

been completed.[81] Given the risk associated with the transmission of radiofrequency energy in a medium charged with highly flammable natural gas, it may be reasonable to expect that rollout of this technology will be slow. One industry analyst notes:

> "In theory it could work. Ultra wideband technology is pretty tolerant. But I'm not sure how well it could work within all the twists and turns inside a natural-gas pipe."[82]

Whether BIG even makes it to the commercial trial phase is a question yet to be answered.

e. Market Dynamics

As Professor Yoo admits, competitive last-mile broadband markets do not exist today. If competition is to emerge, then the technologies discussed above will provide the technical platforms on which the business cases for raising investment dollars will need to be based. What is clear is that today's two major broadband providers, cable television and incumbent telephone companies, are rushing to deploy fiber closer to consumers. This deployment is likely to affect the feasibility of other platforms. Whether fixed wireless or BPL will be able to compete once fiber has been deployed by first moving incumbents, who already have established customer relationships associated with the delivery of broadband Internet access and other services, is not assured. Fiber will be capable of providing consumers much higher transmission speeds than either BPL or wireless are capable of providing. Economic theory also tells us that the sunk investments in fiber made by incumbents will enable the incumbents to make credible threats regarding price cuts in the face of entry.[83] The first-mover advantages of incumbent fiber deployments are likely to weigh heavily on alternative technologies.

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81 Nethercomm "Proof of Concept." Accessed March 1, 2006 at: http://www.nethercomm.com/proof.pdf

82 "Gas pipe broadband?" Cnet News, November 11, 2005. Accessed March 1, 2006 at: http://news.com.com/Gas+pipe+broadband/2100-1034_3-5945204.html

83 Tirole, J., *The Theory of Industrial Organization*, MIT Press, 1989, pp. 314-315.

Broadband over power lines may have the potential to provide a broadband pathway into a large number of homes. However, whether BPL's relatively low transmission speeds will be viewed as competitive in areas where fiber is deployed is a pressing question. Likewise, fixed wireless alternatives may provide reasonable overbuild potential in areas characterized by flat terrain, and limited foliage interference. However, transmission speeds associated with commercial WiMax offerings may not stand up to fiber-based offerings.

It is also important to note that the first movers in the broadband market (i.e., the cable and telephone companies), are planning on offering consumers a bundle of services which reaches far beyond broadband Internet access. High-end customers will be enticed with packages which include local and long-distance calling, broadband Internet access, wireless plans, and video programming.[84] The bundling approach to providing services is widely recognized as reducing "customer churn,"[85] thus making it more difficult for any new entrants in the last-mile broadband market to capture incumbent market share.

For competition in the last mile to emerge, prospective entrants are influenced by the existing state of the market. New entrants must make their case in the capital markets that the market for broadband access is capable of supporting multiple firms, each providing a high-speed connection to the end-user. Not only will these firms face incumbents with pre-existing customer relationships, but new entrants must also acknowledge that once their networks are built, even in the best scenarios, their networks will have low take-rates due to market saturation. One analyst associated with fiber roll-outs notes:

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84 "Optimizing the network architecture for Triple Play," Alcatel Strategy White Paper, 3rd Quarter 2005. Accessed March 1, 2006 at: http://www.alcatel.com/doctypes/opgrelatedinformation/TriplePlay_wp.pdf

85 *Id.* p. 2. See also, Owens, T. "Strategic Bundling Delivers Bundles of Joy," *Rural Telecommunications*, January/February 2000; and, Stagnaro, J. "The Chattel Call," *America's Network*, December 1, 1999.

> When talking about the business case for FTTH, a great deal of attention is typically given to the cost of components. While such costs are obviously important, take rates, (the percent of consumers taking service over FTTH) actually have much more impact on FTTH feasibility and return-on-investment.[86]

Thus, at a basic financial level, the prospects of multiple broadband pipes reaching consumers is undermined by incumbent first-mover advantages. Capital markets will not look favorably on requests for funds which will be used for sunk investments in duplicate last-mile broadband facilities which can only hope to generate low take-rates. Even ignoring the issue of whether other technology platforms will be viewed as desirable alternatives once fiber is deployed, it is easier to envision pockets of competition from multiple platforms, especially in high-income areas, than the widespread availability of multiple last-mile competition critical to the network diversity proposition.

2. 3G Wireless Offers a "Peek" into the Possible Outcome of a Network Diversity Policy

Professor Yoo also identifies third-generation wireless (3G) as another potential last-mile alternative.[87] These services offer mobility, but limited data speeds, Verizon notes that its 3G plan may provide data "bursts" of up to 2Mbps, but that more realistic speeds are 400- 700 kbps.[88] Furthermore, 3G wireless data plans may include significant limitations on use, and provide a window into the restrictions which are likely to be placed on end-users in the world of proprietary data networks advocated by Professor Yoo. For example, the terms of service of a Verizon 3G plan state as follows:

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86 Michael Render, "If You Build It. . . Will They Come?" Render Vanderslice & Associates, August 2004. "FTTH" abbreviates fiber to the home. Accessed March 1, 2006 at: http://www.ftthcouncil.org/documents/572883.pdf

87 Yoo, p. 25.

88 Plan information accessed March 1, 2006 at: http://www.verizonwireless.com/b2c/promotion/controller?promotionType=miniPac&action=miniStart

Unlimited NationalAccess/BroadbandAccess:

> Subject to VZAccess Acceptable Use Policy, available on www.verizonwireless.com. NationalAccess and BroadbandAccess data sessions may be used with wireless devices for the following purposes: (i) Internet browsing; (ii) email; and (iii) intranet access (including access to corporate intranets, email and individual productivity applications like customer relationship management, sales force and field service automation). *Unlimited NationalAccess/BroadbandAccess services cannot be used (1) for uploading, downloading or streaming of movies, music or games, (2) with server devices or with host computer applications, including, but not limited to, Web camera posts or broadcasts, automatic data feeds, Voice over IP (VoIP), automated machine-to-machine connections, or peer-to-peer (P2P) file sharing, or (3) as a substitute or backup for private lines or dedicated data connections.* NationalAccess/BroadbandAccess is for individual use only and is not for resale. We reserve right to limit throughput or amount of data transferred, deny or terminate service, without notice, to anyone we believe is using NationalAccess or BroadbandAccess in any manner prohibited above or whose usage adversely impacts our network or service levels. Verizon Wireless reserves the right to protect its network from harm, which may impact legitimate data flows.[89]

The fact that the service has usage restrictions associated with uploading, streaming, VoIP, peer-to-peer, or as a substitute or backup for a dedicated data connection indicates that the constraints placed on 3G technology may limit its desirability to mobile business solutions (for which 3G is currently marketed), and not offer a general last-mile alternative. Furthermore, if these types of restrictions were placed more broadly on network users, due to the rise of closed-access last-mile networks, the impact on innovation would be pronounced. If, for example, end-users have limited upload capabilities or cannot use a service for streaming, then the incentive to innovate in these areas is greatly reduced.

C. Summary on Potential for Competitive Last-Mile Broadband

In summary, multiple broadband networks do not exist now, and multiple technological overbuilds face major hurdles. Given that Professor Yoo envisions the possibility of three tiers of last-mile services, the overbuilding of multiple last-mile facilities for each type of last-mile service seems even less likely. Ignoring the lack of incentives resulting from low-value

89 Id.

"separate but optimized" networks, it is also clear that incumbents are very concerned about multiple broadband facilities, especially fiber-based networks, and incumbent telephone and cable companies have taken actions to limit the potential for the overbuilding which Professor Yoo identifies as necessary for a successful "network diversity" policy to be implemented. Furthermore, it is reasonable to expect that overbuilds are much more likely to occur in areas where consumer incomes are higher. A policy based on network diversity would thus favor those in high-income areas and leave others dependent on an inferior access arrangement, one where there would be no hope of market forces disciplining the exclusionary and discriminatory actions of the broadband access provider.

III. Other Issues with Professor Yoo's Arguments

A. Professor Yoo Selectively Interprets the Economics Literature Regarding Vertical Integration

The consequence of a policy of network diversity will be increased "vertical integration," a process where the owners of last-mile broadband facilities will provide content, services, and applications which are currently provided by unaffiliated third-parties today. To lend support to his position on the desirability of vertical integration, Professor Yoo points to what he alleges is a "sea change" in economic theory relating to vertical integration.[90] His support for this proposition points to a particular point of view, that associated with the Chicago School of economics. Chicago School theory posits that vertical integration is always efficiency enhancing.[91] However, the world is not as simple as that envisioned by the Chicago School. The

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90 Yoo, p. 13.

91 Professor Yoo (footnote 15), cites several Chicago School classics on vertical integration, and also references his own work which appeared in the *Yale Journal of Regulation* in 2002. Professor Yoo's *Yale Journal* paper explicitly identifies the Chicago School as the source of Professor Yoo's inspirations and conclusions, rather than speaking as if all of the economics literature is in harmony with the
(continued...)

economic models associated with the Chicago School's views of vertical integration generally ignore market structures other than pure monopoly and pure competition, and do not address market dynamics.[92] Furthermore, the Chicago School does not make a compelling case for vertical integration when a monopolist absorbs competitive firms.

While Professor Yoo argues that the economics of vertical integration rest solely on the Chicago School's interpretation, he overlooks the extensive literature associated with post-Chicago analysis of vertical relationships.[93] This alternative literature rejects the simplified structure of the Chicago School's approach to vertical relationships and utilizes the tools of modern industrial organization theory to analyze market structures which are more complex (and realistic) than the approach taken by the Chicago School.[94]

The post-Chicago approach offers a more balanced approach to the evaluation of vertical integration, the following discussion from the post-Chicago literature regarding the evaluation of mergers resulting in vertical integration illustrates this point:

> The Chicago School critique of vertical merger policy has precipitated a more refined analysis of vertical mergers. These new post-Chicago theories neither ignore nor reject the economic analysis of the Chicago School. Instead, they apply the newer

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[91](...continued)
Chicago School, as he does in the paper which is the subject of this critique.

[92] F.M. Scherer and David Ross, *Industrial Market Structure and Economic Performance, 3rd ed.* Houghton Mifflin Company, Boston, 1990, p. 522.

[93] See, for example, Michael Riordan and Steven Salop, "Evaluating Vertical Mergers: A Post-Chicago Approach," *Antitrust Law Journal, Vol. 63*, 1995; Oliver Hart and Jean Tirole, "Vertical Integration and Market Foreclosure," *Brookings Papers on Economic Activity*, 205, 1990; Martin K. Perry, "Vertical Integration: Determinants and Effects," in *Handbook of Industrial Organization*, (Richard Schamlensee and Robert Willig eds.) 1989; Jean Tirole, *The Theory of Industrial Organization*, Chapter 4, MIT Press, 1989.

[94] David S. Evans and Michael Salinger. "Competition Thinking at the European Commission: Lessons from the Aborted GE/Honeywell Merger," George Mason Law Review, Vol. 10, Spring 2002, p. 512.

> methodology of modern industrial organization theory to more realistic market structures in which vertical mergers can have anticompetitive effects. Although this scholarship certainly does not suggest a return to the *Brown Shoe* view of vertical mergers, it does identify situations where vertical mergers and other vertical restraints can raise significant competitive concerns.[95]

Professor Yoo also ignores the very relevant post-Chicago literature regarding the ability of firms with market power to raise the costs of potential rivals.[96] Cost raising strategies pursued by last-mile broadband providers are of particular concern, given statements made by broadband providers and their equipment suppliers, which are discussed elsewhere in this paper.

That the vertical integration resulting from the policy of "network diversity" advocated by Professor Yoo would cause harm to consumers is abundantly clear. As is discussed elsewhere in this paper, the likelihood of consumers having numerous alternative broadband providers is very low. While high income, high density areas may see more choice, most consumers will not. A policy of closed access, combined with vertically integrated monopoly (or duopoly) providers of broadband access facilities will reduce the vibrant competition for Internet content, applications, and services which is apparent today. This reduction in competition will harm consumers. However, it is also important to note that restrictions placed on end-users (who also may be producers of Internet content and applications), with regard to what devices they may attach to the Internet, or how they utilize their broadband connection, will add another layer of harm to consumers through the suppression of innovation.

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95 Riordan and Salop, "Evaluating Vertical Mergers: A Post-Chicago Approach," *Antitrust Law Journal, Vol. 63,* 1995, p. 515.

96 See, for example, Salop, S.C. and Scheffman, D.T. "Raising Rivals' Costs." *American Economic Review*, Vol. 73, No. 2 (1983). For a summary of the cost-raising literature, see David Scheffman and Richard Higgins, "20 Years of Raising Rivals' Costs: History, Assessment, and Future," *George Mason Law Review,* Winter 2003. A prepublication mimeo is available at: http://www.ftc.gov/be/RRCGMU.pdf

B. Professor Yoo's Argument that Network Neutrality Undermines Product Differentiation is a Red Herring

Professor Yoo argues that standardization resulting from network neutrality results in lower levels of consumer welfare.[97] The reason for this alleged reduction in consumer welfare is the inability of consumers to take advantage of *product differentiation* when a standardized product is mandated. There are a number of problems with Professor Yoo's argument, the first of which is that network neutrality results in standardization at the wholesale level. Protocol standardization affects Internet content, services, and applications as an *input* in the production of the tremendous (and highly differentiated) variety of content, services, and applications which utilize the standardized Internet protocols.

In support of his proposition that standardization reduces consumer welfare, Professor Yoo again turns to the economics literature:[98]

> . . . leading network theorists have recognized that limiting product variety can "prevent the development of promising but unique and incompatible new systems." Standardization can thus represent an important, but often unnoticed, source of welfare loss.[99]

The material in quotations attributed by Professor Yoo to "leading network theorists" is a work by Katz and Shapiro which appeared in a 1994 issue of the *Journal of Economic Perspectives.* However, Professor Yoo's apparently misreads Katz and Shapiro. The discussion from which Professor Yoo draws the quoted material is a section of Katz and Shapiro's article which addresses the "Social Benefits and Costs of Compatibility." On this issue, Katz and Shapiro

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97 Yoo, p. 15.

98 At footnote 18, Professor Yoo references works by Katz and Shapiro, and Farrell and Saloner.

99 Yoo, p. 17, footnote referencing quoted material omitted (the quote is from the Katz & Shapiro article "Systems Competition and Network Effects, *Journal of Economic Perspectives,* Vol. 8, 1994, p. 110.)

note:

> For communications networks, compatibility expands the size of each network to the total membership of both. This raises the gross consumption benefits enjoyed by a consumer who subscribes to only one firm's network, and avoids the cost of having to hold duplicate equipment to participate in two different networks to reach everyone. . . .
>
> The potential costs of compatibility depend upon the mechanism by which compatibility is achieved. Broadly speaking, there are two mechanisms: standardization, whereby systems are designed to have interchangeable components; and adapters, which attach to a component of one system to allow it to interface with another system. With adapters, the principal cost is that of the adapters themselves, plus the fact that adapters may work imperfectly. By contrast, the primary cost of standardization is a loss of variety: consumers have fewer differentiated products to pick from, especially if standardization prevents the development of promising but unique and incompatible new systems.[100]

The last line of the quoted section immediately above is the language which Professor Yoo provides in support of the "economic proof" that standardization causes welfare loss. However, placing the Katz and Shapiro quote into its original context reveals conclusions which are exactly the opposite of those suggested by Professor Yoo. Katz and Shapiro note that substantial benefits of network compatibility are inevitable. Rather than concluding that limitations on product variety prevent the development of new systems, Katz and Shapiro conclude that there may be fewer differentiated products to choose from ***if*** standardization prevents the development of promising yet incompatible new systems. This is a very big "if" when it comes to the open network protocols which underlie the operations of the Internet.

Katz and Shapiro describe a benefit/cost approach to the issue. Namely, the benefits of standardization must be weighed against the costs from the chance that some new and incompatible system might suffer as a result of standardization. With regard to the standardization of Internet protocols, the variety of services, content, and applications which are currently enabled through the policy of network neutrality must be weighed against the harm

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[100] Katz and Shapiro, pp. 109-110, footnotes omitted.

which would result from abandoning standardization for a policy of incompatibility and network diversity advocated by Professor Yoo. Clearly, the immediate impact on consumers which would result from the reduction of system compatibility would eliminate the substantial existing benefits of compatibility discussed by Katz and Shapiro. The benefits of network diversity are highly speculative at this time, and as was discussed earlier, the primary benefit identified by Professor Yoo, an allegedly increased incentive to invest in new last-mile broadband systems, is doubtful. On balance, shifting to a policy of incompatibility and network diversity will likely result in a significant reduction in consumer welfare, with little hope of future offsetting gains.

The standardization of Internet protocols has been achieved in a manner which is the most humble to designers of new technologies, current and future. This humility, embodied in the core principals of the basic Internet protocols, stands in contrast to the "technological humility" to which Professor Yoo points.[101] Professor Yoo's approach would enable the creation of proprietary, exclusive, and exclusionary protocols, which would be controlled by the owners of broadband networks. Professor Yoo points to the undesirability of government influencing standardization as it will result in the government "picking winners and losers."[102] However, the proprietary protocols associated with network diversity will disable widely varied and differentiated innovations which thrive in the standardized open protocol environment of today. Network owners will be able to "pick the winners," and we can be sure that the winners will be required to pay tribute to the network owners.

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101 Yoo, pp. 7, 21, 53, 54.

102 Yoo, p. 4. It should be noted that the development and modification of protocols utilized on the Internet is not dictated by governments, but developed though a process open to all interested parties.

IV. Conclusion

Network neutrality has generated substantial benefits for consumers. Innovation and investment at the network edge have been promoted through this policy. The substantial investments in Internet backbone facilities, investments which have led to a massive glut in long-haul fiber-based transmission facilities,[103] have also been induced under a policy of interconnection and open access. Those who advocate that the highly successful and beneficial policy of open access should be replaced bear the burden of proof that any alternative will result in a superior outcome. Professor Yoo's arguments regarding the desirability of a policy of network diversity do not provide support for the proposition that consumers will be made better off. Rather, there is substantial evidence that Professor Yoo's approach will result in substantial harm to consumers, investment, and innovation. Professor Yoo's suggestion that policy makers should have faith that unconstrained firms which possess market power will provide benefits to consumers, and not undermine their competitors, is not supported by his arguments. Humility before firms which exercise market power in markets for last-mile broadband facilities is not good policy.

103 "Why the Glut in Fiber Lines Remains Huge," *Wall Street Journal,* May 12, 2005, p. B1.

Network Neutrality, Product Differentiation, and Social Welfare

A Response to Phoenix Center Policy Paper No. 24

A Policy White Paper Prepared by

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May 3, 2006

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Summary and Overview

This paper will address the issue of network neutrality in light of a recent Phoenix Center Policy Paper by George S. Ford, Thomas M. Koutsky, and Lawrence J. Spiwak, titled "Network Neutrality and Industry Structure," (hereinafter, Ford *et al.*). The focus of the analysis presented here is an examination of Ford *et al.'s* economic model. The critique of Ford *et al.* is directed at four fatal flaws in their analysis, each of which completely undermines their conclusion that policy makers may harm social welfare by pursuing a policy of network neutrality.

- First, Ford *et al.'s* economic modeling does not address economies of scale in last-mile broadband access networks. This assumption is highly unrealistic and ignores the fact that new entrants in broadband last-mile markets are likely to face higher costs, and will likely need to charge higher prices, than incumbents.

- Second, Ford *et al.*'s economic modeling assumes policy makers, by pursuing a policy of network neutrality, can completely eliminate product differentiation among broadband access providers. This assumption is entirely unreasonable—policy makers will not be able to enforce "commoditization" of broadband access as suggested by Ford *et al.* Network neutrality principles and some differentiation of last-mile broadband networks are not mutually exclusive.

- Third, the approach taken by Ford *et al.* is fatally flawed as they fail to acknowledge the impact of the abandonment of network neutrality on the consumption and production of Internet content, services, and applications. By excluding this important consideration, Ford *et al.'s* approach is overly narrow. Any evaluation of a shift in policy must appropriately identify costs and benefits of alternative actions, and Ford *et al.'s* approach fails to acknowledge the tremendous decline in social welfare which is likely to arise should last-mile broadband access providers be allowed to engage in discrimination against providers of Internet content, applications, and services, an action which would reduce competition, product variety, and customer choice.

- Fourth, the conclusions which Ford *et al.* draw from their model depend on the existence of low levels of sunk costs associated with constructing new last-mile access networks This assumption is highly unrealistic. If sunk costs of entry are high (which they are), the proposition that network neutrality will harm social welfare is not supported by Ford *et al.'s* model.

It is notable that with regard to the issues of scale economies, product differentiation, and sunk costs, Ford *et al.* ignore positions which they have previously taken on the importance of these market characteristics on the potential for competition to emerge in last-mile networks.

This white paper then offers a brief conclusion regarding the issue of network neutrality in light of Ford *et al.'s* evaluation.

A Note on Terminology

The terms "network neutrality" or "open-access Internet," as I use them in this white paper, should be understood to reflect outcomes resulting from many of the pro-competitive policies which have been enforced in telecommunications markets in the U.S. The ability of end-users to attach equipment of their choice, the provision of access on nondiscriminatory terms to bottleneck facilities, and the requirement that network providers interconnect are examples of these pro-competitive policies. Network neutrality is also consistent with the end-to-end network principles which have been associated with the operations of the Internet. The Internet has operated in a "neutral" environment of open standardization, interconnection, and deference to the network edge, an environment which has generated substantial benefits for consumers, firms, and society.

While the influences discussed above led to an Internet that was "neutral," changes in policy have opened the possibility that the previous "neutral" Internet may be threatened. Whether a permanent and enforceable policy of network neutrality should be adopted is the main point of conflict as the potential for new telecommunications legislation unfolds.

Table of Contents

I. The growing threat to the open-access Internet

The future of the Internet is the center of an intense debate. At the foundation of the debate is a dispute as to whether or not the firms that control network infrastructure, especially last-mile broadband access facilities, should be allowed to "differentiate their product." Network differentiation, while possibly associated with relatively benign technology differences across broadband platforms, may also be associated with last-mile broadband access providers engaging in the strategic manipulation of technology, which will enable discriminatory practices that adversely affect the utilization and production of Internet content, services, and applications.[1] Those advocating for strategic "network differentiation" have gone as far as to suggest that abandonment of protocol standardization, the foundation of the Internet, could be beneficial.[2]

Consumers today face very few choices of broadband Internet access services.[3] The reason for the lack of choice of broadband access provider is the pervasive and substantial fixed and sunk costs associated with building alternative networks. However, today consumers enjoy a tremendous variety of, and competitive supply of, Internet services, content, and applications, which are accessed through a broadband (or dial-up) connection. Furthermore, producers of

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1 A more detailed discussion of issues related to the network neutrality debate is provided in another Roycroft Consulting white paper: "Network Diversity—A Misguided Policy," by Trevor R. Roycroft. Available at: www.roycroftconsulting.org/response_to_Yoo.pdf

2 See, for example: Christopher Yoo, "Promoting Broadband Through Network Diversity." http://law.vanderbilt.edu/faculty/Yoo%20-%20Network%20Diversity%202-6-06.pdf

For a response to Professor Yoo's arguments and additional discussion of network neutrality issues, see: Roycroft, *op. cit.*

3 The most recent statistics available from the FCC indicate that about 96% of consumers who use broadband do so with either a cable modem or telephone company DSL connection.

Internet content, services, and applications have an equal opportunity to serve the market and earn profits. This competition and product variety is the result of a legacy of Internet governance which encouraged nondiscriminatory access, standardized network protocols, and network interconnection. The competition and product diversity also reflects the heritage of regulatory policies which required the provision of access to the Internet on a nondiscriminatory basis. Thus, in economic terms, the overall welfare of society has been positively influenced by the regime of openness which has dominated the Internet to date.

The potential now arises, due to a series of decisions regarding the regulatory treatment of broadband Internet access facilities, such as cable modem and telephone company DSL connections, that the neutrality of network facilities may be eliminated.[4] This may result in the introduction of proprietary and non-standardized network protocols, or packet prioritization and discrimination. Abandonment of network neutrality principles will enable the owners of last-mile broadband access facilities to create "differentiated," and possibly incompatible and exclusive, networks. Alternatively, if network neutrality principles are abandoned, the owners of last-mile broadband access networks may discriminate against applications and services which do not fit with their revenue generation plans. If the owners of last-mile broadband access facilities differentiate their networks, and discriminate or place limits on consumer choice, the result will be a dramatic reduction in competition and the variety of Internet services, content, and applications which consumers currently utilize. Furthermore, a highly tilted playing field will be created, where the owners of last-mile broadband access facilities will be able to hamstring their competitors, undermining innovation and investment in what, to date, has been a highly competitive market for Internet content, applications, and services.

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[4] For further discussion, see Roycroft, *op. cit.*, pp. 3-5.

Policy makers must carefully consider the impact of any decision which might alter the current structure of the Internet, a structure which allows Internet users to access the content and applications of their choice, and has encouraged competition and substantial investment by firms which produce Internet content, services, and applications. At the heart of the arguments against network neutrality, which are typically offered by telephone and cable companies and their advocates, are claims that the Internet's true potential can only be achieved if multiple last-mile broadband access facilities are constructed. This alternative has been called "network diversity,"[5] or has been associated with calls for "differentiated last-mile networks." Thus, the focus of the policy debate, as framed by those that advocate for the ability of telephone and cable companies to differentiate their networks, and exclude and discriminate, often turns on the alleged negative impact that network neutrality will have on incentives for alternative last-mile facilities to be constructed.[6]

A recent addition to the argument that network neutrality can undermine last-mile broadband competition is a white paper by George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak titled "Network Neutrality and Industry Structure"[7] (hereinafter "Ford *et al.*"). The major policy recommendation offered by Ford *et al.* is that policymakers "should avoid network neutrality mandates that have the intent or effect of 'commoditizing' broadband access services since such a policy approach is likely to deter facilities-based competition, reduce the expansion

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5 See, for example, "Dueling Network Buzzwords: 'Neutrality''Versus 'Diversity'," National Journal's Telecom Insider, February 6, 2005. http://www.njtelecomupdate.com/lenya/telco/live/tb-MBSE1139339451850.html

6 A discussion of the prospects of last-mile broadband competition is contained in Roycroft, *op. cit.,* pp. 26-39.

7 The paper is sponsored by the Phoenix Center for Advanced Legal and Public Policy Studies. See, George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Network Neutrality and Industry Structure," April 2006. Available at: http://www.phoenix-center.org/ppapers.html

and deployment of advanced communications networks, and increase prices."[8]

"Commoditizing" broadband access means any policy which limits the network owner's ability to differentiate its network from other networks:

> This restriction on network differentiation can manifest itself in several ways. For example, rules may require broadband providers to offer access services separate and apart from affiliated content (i.e., privacy, security, packet prioritization, VoIP services) or limit the manner in which they can charge for various ancillary services.[9]

Ford *et al.* note that "policies that promote commoditization of broadband access could lead to the monopoly provision of advanced broadband services in many markets."[10] The authors conclude that "allowing broadband firms to differentiate their products may make entry more likely, thereby leading to a less concentrated industry structure."[11] Ford *et al.* offer support for the proposition that network neutrality may harm social welfare,[12] and their conclusions may encourage policy makers to tread on network neutrality principles.[13]

Ford *et al.* support their position with a "rather technical economic model."[14] Economists frequently rely on economic models to simplify complex market problems, and economic models

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8 Ford, *et al.* p. 1.

9 Ford, *et al.* p. 8.

10 Ford, *et al.* pp. 2-3.

11 Ford, *et al.* p. 3, footnote omitted.

12 Social welfare, as defined by economists, includes both the profits of the supply side of the market and the "consumer surplus" of the demand side of the market.

13 Ford *et al.* assert that they "argue neither for nor against the need for Network Neutrality legislation. . ." (p. 2.) It is difficult, however, to interpret their analysis, which purports to show social harm from network neutrality, while legislation on network neutrality is being debated in Congress, as a "neutral" contribution to the debate.

14 Ford *et al.*, p. 3.

have the potential to enable a clearer view of the potential impact of various policy alternatives. However, it is also true that complex economic models may be used to obfuscate and confuse.[15] It is important to examine the conclusions offered by Ford *et al.* in the context of their economic model, as absent the economic model, Ford *et al.* offer policy recommendations which have no foundation. Ford *et al.* indicate that their analysis is "focused,"[16] however, their approach is too narrow to provide any useful conclusions. As will be discussed in detail below, Ford *et al.'s* analysis is based on a highly restrictive set of assumptions, and these limiting assumptions prevent any general conclusions from being drawn from their analysis. However, it is important to examine their claims as it is all too likely that their findings will be utilized by others to support *broad arguments* against network neutrality principles.

II. Evaluation of Ford *et al.'s* economic model

Economic models have the potential to provide insight for policy makers. However, it is all too easy to abuse economic models and economic theory in policy discussions. To quote a recent observation by an economist of note on this issue:

> Economic theory is often abused in practical policy-making. There is frequently excessive focus on sophisticated theory at the expense of elementary theory; too much economic knowledge can sometimes be a dangerous thing. Too little attention is paid to the wider economic context, and to the dangers posed by political pressures. Superficially trivial distinctions between policy proposals may be economically significant, while economically irrelevant distinctions may be politically important.[17]

As will be discussed in detail below, Ford *et al.'s* analysis does not have sufficient "economic

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15 See, for example: Klemper, Paul. "Using and Abusing Economic Theory," *Journal of the European Economic Association*, April-May 2003, p. 272-300. Available at: http://www.nuff.ox.ac.uk/economics/papers/2003/W2/usingandabusing.pdf

16 Ford *et al.*, p. 4.

17 Klemper *op. cit.*

context," and as a result, they offer policy recommendations which are not supported by a reasonable application of economic theory.

My criticism of Ford *et al.'s* economic model is directed at four issues. First, Ford *et al.'s* model does not acknowledge economies of scale which are pervasive in last-mile broadband networks. Second, Ford *et al.'s* economic model assumes that policy makers are capable of eliminating all product differentiation in the provision of broadband Internet access facilities. This assumption is highly unrealistic. Third, while claiming to offer an analysis based on the evaluation of *social welfare*, they exclude important aspects of the market and develop an overly narrow "social welfare" evaluation.[18] Ford *et al.* completely ignore the impact that the elimination of network neutrality will have on the production and consumption of Internet content, applications, and services. Thus, Ford *et al.'s* model ignores the substantial harm to social welfare which would arise if telephone and cable companies act as gatekeepers and interfere with competition and consumer choice, and the ability of businesses to invest and market their services over the Internet. Fourth, Ford *et al.'s* conclusions are based on the assumption that *sunk costs* associated with entry in last-mile broadband access markets are negligible. This assumption is also highly unrealistic and further undermines the credibility of their conclusions.

A. Scale economies must be considered when evaluating broadband access network policy

One notable characteristic of Ford *et al.'s* model is the absence of *scale economies* in last-mile broadband access networks. In other words, there are no cost advantages associated with firm size, the unit cost of production for the incumbent monopoly firm producing all output

18 Social welfare, as understood by economists, is the sum of *consumer surplus* and *producer surplus.*

is exactly the same as the unit cost for each firm when competition is introduced.[19] This is a highly unrealistic assumption. Other writers on the subject of the alleged advantages on "network diversity" have acknowledged that entrants may face higher operating costs than incumbents, and thus need to charge higher prices than the incumbent. For example, Christopher Yoo's recent white paper which also attacks network neutrality and provides a favorable evaluation of the prospects for "network diversity," acknowledges that scale economies exist, and he opines that differentiated networks could overcome their cost disadvantage by charging higher prices for their differentiated services because consumers will value the differentiated services more highly.[20] While Ford *et al.* do mention the possibility that network differentiation increases consumer valuation of the last-mile broadband network, their evaluation of this aspect of differentiation does not consider the higher costs facing an entrant due to the entrant's lack of scale economies.[21]

The absence of scale economies from Ford *et al.'s* analysis is a fatal flaw. Ironically, as will be discussed further below, Ford *et al.* have elsewhere addressed the negative impact of scale economies on the prospects of entry in last-mile markets.

B. Network neutrality and last-mile broadband differentiation are not mutually exclusive

It is important to note that network neutrality and product differentiation among last-mile broadband networks are not mutually exclusive as Ford *et al.* assert. Rather, the coexistence network neutrality and differentiation of last-mile facilities is an entirely reasonable prospect.

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19 The cost structure assumed by Ford *et al.* results in the same unit costs for the firms in question under the cases of monopoly and duopoly, as shown in their equations (7), (17), and (25).

20 Christopher Yoo, "Promoting Broadband Through Network Diversity," *op cit.*, p. 24. For a critique of Professor Yoo's argument, see, Roycroft, *op. cit.*

21 Ford *et al.*, p. 19.

Principles of network neutrality require that last-mile broadband providers do not engage in discrimination or sabotage of the offerings of competing providers of Internet content, services, and applications. However, network neutrality principles may be upheld and differentiation of last-mile access facilities may exist, especially if differentiation is associated with technical differences in the broadband platform, and is not the result in strategic manipulation of technology. Ford *et al.'s* model is flawed as it assumes that the pursuit of a network neutrality policy will prevent last-mile access providers from operating differentiated networks. It is important to keep in mind that Ford *et al.'s* economic modeling assumes that policy makers can force competing broadband networks to be *absolutely identical*.[22] This assumption is highly unrealistic, and the conclusions which Ford *et al.* draw from their model are tenuous as a result.

Technology differences in last-mile broadband facilities naturally introduce product differentiation. Ford *et al.* recognized the fact that different technological delivery platforms may have inherent differentiation in a July 2005 paper, a portion of which addressed differences between cable television and direct broadcast satellite (DBS) systems:

> A recent study by the General Accounting Office ("GAO") on competition between cable television and DBS firms illustrates the importance of product differentiation. While both terrestrial and satellite multichannel video providers offer similar products, there are some meaningful forms of differentiation between the two. The differences in the delivery technology itself (i.e., inter-modality) are not lost on consumers.[23]

Similar differentiation in technology resulting from "inter-modality" is associated with last-mile broadband facilities, and policy makers will not be able to eliminate this type of differentiation.

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[22] In the notation of their model, policy makers can force the parameter $\theta = 1$. Ford *et al.* p. 18.

[23] George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Competition After Unbundling: Entry, Industry Structure and Convergence," Phoenix Center Policy Paper Number 21, July 2005, p. 24. Available at: http://www.phoenix-center.org/ppapers.html

For example, last-mile broadband in cable networks are a shared resource, multiple consumers share cable broadband access networks from a point very near the customer's premises. The impact of this sharing is the delivery of variable bandwidth to end users based on how many of the end user's neighbors are also requesting bandwidth. Telephone company DSL, on the other hand, provides fixed bandwidth in the access network, and essentially bypasses the potential for "network congestion in the neighborhood" which is associated with cable systems. Marketing by DSL and cable providers enable consumers' ability to recognize the fact that DSL and cable broadband access are differentiated products. Consumers are aware that with cable broadband "actual speeds may vary and are not guaranteed,"[24] and that "DSL provides a dedicated connection . . . so you don't have to share your local access connection with other users."[25]

Other technologies used for broadband Internet access have characteristics which result in differentiation. For example, fixed wireless broadband networks may offer a more scalable service, and symmetrical bandwidth.[26] Alternatively, mobile wireless broadband introduces mobility. These characteristics are product differentiation which will not be affected one iota by network neutrality requirements.

In addition, one of the main points of differentiation in last-mile access facilities is the amount of bandwidth which is offered to consumers. Coaxial cable, DSL, fiber to the home, and fixed and mobile wireless access services routinely use download and upload speeds as points of differentiation, and it is entirely unreasonable to expect that a policy of network neutrality would result in this fact changing. If network neutrality is consistent with some product differentiation

[24] Comcast broadband description. http://www.comcast.com/Benefits/CHSIDetails/Slot3PageOne.asp

[25] Verizon broadband description. http://www22.verizon.com/forhomedsl/channels/dsl/learnmore/faqs/#tech2

[26] http://www.znet.com/fixedwireless/

among last-mile providers (which it is), then none of the conclusions derived from Ford *et al.'s* economic model are valid. Their model assumes that policy makers have the ability to eliminate all product differentiation, and this is simply not the case.

C. Ford *et al.'s* modeling ignores the tremendous impact on social welfare that broadband gatekeepers will cause

Ford *et al.* argue that network neutrality can result in lower levels of social welfare.[27] The reason for this reduction in welfare is the alleged inability of consumers to take advantage of broadband access *product differentiation* when network neutrality is mandated. However, Ford *et al.* analyze only one part of the picture. Failure to maintain network neutrality may dramatically decrease the competition and product variety that consumers currently enjoy with regard to Internet services, content, and applications.[28] Thus, one major problem with Ford *et al.'s* economic model is that they ignore the fact that elimination of network neutrality principles will reduce competition, customer choice, and product variety which currently exists for Internet content, applications, and services. The introduction of discriminatory and exclusionary practices by last-mile broadband gatekeepers will likely lead to a reduction in competition, customer choice, and product variety. Thus, Ford *et al.'s* model fails to address the substantial loss in social welfare which would likely occur should telephone and cable companies become gatekeepers and discriminate against Internet services, content, and applications which were not consistent with the gatekeepers' revenue generation plans. This loss in social welfare must be accounted for in any analysis of the alleged gains in consumer welfare arising from "differentiated" last-mile networks.

However, Ford *et al.'s* oversight is even more significant as it appears that they have

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[27] Ford *et al.*, p. 18.

[28] For a further discussion of this issue, please see: Roycroft, *op. cit.*, pp. 5-11.

forgotten the basic economics of the evaluation of product differentiation, i.e., that the costs and benefits of differentiation must be thoroughly evaluated. The economics literature recognizes product differentiation as means through which firms can undermine price competition,[29] and the resulting reduction in price competition may harm consumers. It is notable that in another paper authored Ford *et al.* in July of 2005, they clearly recognized the importance of evaluating the benefits and costs of product differentiation, and identify issues with product differentiation which they now ignore completely:

> The effect of differentiation on prices can be significant. At the extreme, two products can become so different that they no longer are substitutes for one another – while both made by General Motors, a Hummer is not really a viable substitute product for a Chevette. *Accordingly, we should expect firms to attempt to differentiate their products as much as possible in order to soften price competition.*
>
> As to whether consumers are better off as a result of product differentiation, the answer is "it depends." Consumers usually value variety, *so while differentiation results in higher prices, the value of increased variety may offset the reduction in consumer welfare from higher prices.* So, there is a trade-off for consumers between variety and price. Differentiation is not always beneficial to consumers, and some firms may excessively differentiate in an effort to more aggressively soften price competition. *One type of differentiation that would harm consumers is differentiation through sabotage, where one firm reduces the quality of a rival's product instead of improving its own quality.* Product differentiation may also create entry barriers by forcing entry to incur increased sunk advertising costs to win customers.[30]

In this previous work Ford *et al.* recognize many important facts regarding product differentiation which they now ignore. Product differentiation may reduce competition. The reduction in competition generates higher prices. As a result, consumers may not benefit from

29 See, for example, Tirole, J. *The Theory of Industrial Organization*, MIT Press, 1989, p. 278.

30 George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Competition After Unbundling: Entry, Industry Structure and Convergence," Phoenix Center Policy Paper Number 21, July 2005, emphasis added, p. 24, emphasis added. Available at: http://www.phoenix-center.org/ppapers.html

differentiation. Furthermore, firms may have the ability to differentiate their product by influencing the quality of a rival's product, an all too real prospect when considering the need for network neutrality policy.

Ford *et al.'s* current evaluation of product differentiation presents an overly simplified and unrealistic view of how a policy which abandoned network neutrality would affect consumers and firms. Ford *et al.* completely ignore the impact of the abandonment of network neutrality on current competition in markets for, and the availability of, Internet content, services, and applications of the consumer's choosing. Ford *et al.'s* analysis also ignores negative impacts on the ability of businesses operating at the network edge to innovate and invest. This aspect of network differentiation in last-mile broadband facilities will have a significant and negative impact on social welfare, but it is completely ignored by Ford *et al.'s* model. Furthermore, the very real possibility that the operators of last-mile broadband access facilities would differentiate their product by sabotaging access to Internet content, applications, and services of the user's choice is a tremendous oversight in Ford *et al.'s* current analysis of product differentiation.[31]

Ford *et al.'s* model offers a highly selective view of the impact of product differentiation on price competition. They abandon the more conventional view that product differentiation may undermine price competition, which they relied on in their July 2005 paper, and now state that product differentiation promotes price competition.[32] In summary on this issue, Ford *et al.'s* model entirely fails to support their policy recommendations as they model only a portion of the overall market, and only a portion of the potential impact of the abandonment of network

31 For a further discussion of the potential for sabotage, see Roycroft, *op. cit.*, pp. 6-9.

32 Ford *et al.*, pp. 8-9.

neutrality principles.

D. Ford *et al.'s* modeling incorrectly assumes that sunk costs of building alternative broadband networks are negligible

It would be reasonable to dismiss Ford *et al.'s* recommendations based on the criticism above. However, it is worthwhile to evaluate Ford *et al.'s* model on its (overly narrow) basis and determine whether the policy recommendations offered by the authors have any support at all.

1. Detailed look at Ford *et al.'s* economic model

Table 1, below, summarizes the five market scenarios evaluated by Ford *et al.* The basic logic of the approach utilized by Ford *et al.* is to develop a measure of social welfare under monopoly and no product differentiation, and to compare that level of social welfare with the level of social welfare which results from the other situations summarized in Table 1.

Table 1: Market Profiles Modeled by Ford *et al.*
Monopoly without product differentiation.
Monopoly with product differentiation.
Duopoly without product differentiation (quantity competition).
Duopoly with product differentiation (quantity competition).
Duopoly without product differentiation (price competition).

Table 2, below, summarizes Ford *et al.'s* findings with regard to the modeling.

Table 2: Summary of Ford *et al.'s* Findings	
Scenario	**Impact on Social Welfare Relative to Baseline**
Monopoly without product differentiation **(Baseline Scenario).**	---
Monopoly with product differentiation.	No change, social welfare not affected as compared to baseline.
Duopoly without product differentiation (quantity competition).	Social welfare may be higher if sunk costs of entry are not too high.
Duopoly with product differentiation (quantity competition).	Social welfare may be higher if sunk costs of entry are not too high.
Duopoly without product differentiation (price competition).	If the sunk costs of entry are greater than zero, then entry will not occur.

Ford *et al.* go on to evaluate their results:

> . . . Recall that *E* is the sunk entry cost of a potential entrant, and π is profit. Based on the analysis above, Network Neutrality rules that promote commoditization are socially inefficient under the following three conditions:
>
> 1. $\pi(\text{duopoly}, \ \theta = 1) < E$;
>
> 2. $\pi(\text{duopoly}, \ \theta < 1) > E$;
>
> 3. $W(\text{duopoly}, \ \theta < 1) - E > W(\text{monopoly})$.
>
> These conditions are summarized as follows. Condition (1) states that a duopoly profit with homogeneous products ($\theta = 1$) is insufficient to cover sunk entry costs; as a result, in this case, entry would not occur. Condition (2) states that duopoly profit with differentiated products ($\theta < 1$) is larger than entry costs; as a result, in this case, entry would occur. Condition (3) states that the total welfare with differentiated duopoly is larger than total welfare with monopoly. These three conditions imply that *Network Neutrality rules are socially inefficient if they reduce the number of firms serving the market, and the excluded firms would have been efficient entrants from social perspective.*[33]

Then, based on this exposition, Ford *et al.* conclude with a proof which purportedly supports the proposition that network neutrality is socially inefficient:

[33] Ford, *et al.*, p. 17, emphasis in the original.

> *Proposition.* Suppose Bertrand competition occurs with entry and $\theta = 1$, but differentiated competition occurs if $\theta < 1$. *If E is positive but not too large, then Network Neutrality is socially inefficient.*
>
> *Proof.* Under Bertrand competition, duopoly profit on entry with $\theta = 1$ is zero, so any positive sunk entry costs prevents entry. Without Network Neutrality requiring $\theta = 1$, a firm may enter with $\theta < 1$, whenever
>
> $$\pi_i^* = \frac{(\alpha - c)^2}{\beta}\frac{(1+\theta)}{(2+\theta)^2} > E > 0$$
>
> If so, then welfare from differentiated duopoly exceeds monopoly welfare. Recalling that monopoly welfare is invariant to the degree of differentiation in this model, Network Neutrality is socially inefficient.[34]

This proof caps their exposition, and contributes to their conclusion that network neutrality is socially inefficient. Their conclusion ultimately hinges on the magnitude of the sunk costs of entry—specifically, it must be the case that sunk costs "are not too large." Sunk costs which are "not too large" is, however, an unreasonable presumption.

2. Substantial sunk entry costs make it unlikely, within the context of Ford *et al.'s* model, that network neutrality is socially inefficient

The extent of sunk costs associated with broadband access networks, like other telecommunications networks, are substantial, and these substantial sunk costs make it much less likely that Ford *et al.'s* model shows that a policy of network neutrality will have a negative impact on social welfare. Ford *et al.* have acknowledged the existence and importance of high levels of sunk costs in other recent writings:

> As consistently demonstrated by academic and Phoenix Center research, and again in this POLICY PAPER, given the *huge fixed and sunk costs* inherent to the construction and commercial operation of communications networks, the equilibrium level of concentration of terrestrial firms in local communications markets (voice, video, and data) will be relatively high. . . . *fewness arises because scale economies and sunk costs limit the number of firms that can profitably serve a market – and local communications networks are notoriously riddled with scale economies and sunk costs.* Any policymaker interested in local

[34] Ford, *et al.*, p. 18, emphasis added.

> communications markets should, therefore, start from the assumption that there will, at best be only a "few" facilities-based firms.[35]

Ford *et al.'s* previous recognition of the importance of scale economies and sunk costs has been abandoned in their approach to network neutrality. This makes their conclusion even more unrealistic. The sunk costs which are recognized by Ford *et al.* as a pervasive characteristic of terrestrial communications firms also apply to nonstandard technologies, such as wireless, fiber optics, and broadband over power lines.[36] The bottom line regarding Ford *et al.'s* modeling is this: the extremely high levels of sunk entry costs associated with the construction of communications networks, including last-mile broadband facilities, make it unlikely that network neutrality principles will decrease social welfare. In other words, even if one overlooks all of the other fatal flaws in Ford *et al.'s* approach, the reality of high levels of sunk costs of building last-mile broadband networks indicates that their model does not support the proposition that network neutrality will harm social welfare.

E. Summary of critique of Ford *et al.*

It is somewhat surprising to find Ford *et al.* now ignoring both data and economic principles with which they exhibited a high degree of familiarity as recently as July of 2005. While claiming that their economic model contains support for the proposition that network neutrality will be harmful to social welfare, the model does no such thing. Scale economies must be considered when evaluating the potential impact of entry on market outcomes. Furthermore, any social welfare analysis must tally the negative impact that cable and telephone company

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[35] George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Competition After Unbundling: Entry, Industry Structure and Convergence," Phoenix Center Policy Paper Number 21, July 2005, emphasis added. Available at: http://www.phoenix-center.org/ppapers.html

[36] For a fuller discussion of the limitations of these alternative technologies, see, Roycroft, *op. cit.,* pp. 29-38.

gatekeepers will impose on consumers and firms. It is all too likely that cable and telephone companies will reduce competition in markets for Internet content, services, and applications, possibly even sabotaging sources of supply which interfere with their revenue generation plans. Ford *et al.* overlook this vital component of welfare analysis as it applies to the issue of network neutrality. Also, it is important to acknowledge the impact of substantial sunk entry costs on the prospects for competition. Again, Ford *et al.* ignore vital facts, and ultimately reach unsupported conclusions regarding alleged harms associated with network neutrality.

III. Conclusion

Ford *et al.* argue that policy makers may do harm if they attempt to enforce a policy which prevents last-mile broadband access providers from differentiating their networks, and which leads to "commoditization" of broadband access. As has been discussed above, it is unreasonable to associate network neutrality with the elimination all differentiation in last-mile networks. Furthermore, Ford *et al.'s* failure to address economies of scale and substantial sunk costs associated with last-mile broadband network also undermines the validity of their recommendations. Finally, their failure to acknowledge the impact of the abandonment of network neutrality principles on existing competition, consumer choice, and product variety associated with Internet content, services, and applications is another fatal flaw. The bottom line is that Ford *et al.'s* claims are not supported by economic theory or their model.

The Internet, operating under a regime of standardized protocols and interoperability, has resulted in expansive consumer benefits. Internet standardization is widely recognized to be beneficial to consumers, as it reduces purchase risks and expands network effects, which increase product values.[37] The standardization associated with the Internet operates at a

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[37] See, for example, Carl Shapiro and Hal Varian, *Information Rules*, Harvard Business School Press, Boston, 1999, p. 233.

"wholesale level." The standardized network protocols reside in logical network layers below the "application level," which is associated with the Internet products used by consumers. Thus, due to the standardization of Internet protocols, consumers are presented with a wide variety of content, applications, and services. Due to the standardization of Internet protocols at the wholesale level, consumers enjoy highly differentiated retail products, and are able to benefit from competition, network effects, and the advantages of interoperability. This open-access environment allows the rise of niche market providers, which can tailor their Internet services to the needs of individuals, again adding to consumer benefits.[38]

History provides a laboratory for the evaluation of consumer reactions to differentiated information networks—consumers have had the opportunity to experience electronic information services operating as differentiated and non-standardized "information strip malls." Prior to the commercialization of the Internet, online service providers such as America Online, GEnie, Compuserve, Prodigy, and Delphi offered consumers the ability to utilize chat and bulletin boards, access electronic news and information, and send e-mail. However, these differentiated systems were not interconnected, and users of one online service generally could not communicate with the subscribers of other online service providers.[39] These proprietary network service providers were, of course, free to innovate in their "network cores." However, the commercialization of the Internet, with its open and non-proprietary standards, provides an object lesson in what consumers have deemed the superior approach—i.e., principles of openness which support innovation at the network edge. Once the expansive network effects and interoperability benefits associated with the Internet became available to any entity which

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[38] *Id.*, p. 187.

[39] *Id.*

abided by the principles of the open-access Internet, the proprietary network model quickly withered. The proprietary services which were offered by online service providers were judged by consumers as inferior to the content, applications, and services, operating under the regime of standardized Internet protocols, which were competitively available over the Internet.

The fact that differentiation of last-mile broadband access networks, if that differentiation applies proprietary protocols or limits consumer choice, will undermine the diversity of Internet content, applications, and services should not be lost on policymakers. The Internet, through its governing principles of openness and nondiscrimination, has encouraged competition and expansive consumer benefits. Ford *et al.'s* flawed findings, if acted upon by policymakers who might undermine network neutrality principles, would endanger this success and risk replacing vibrant competition and extensive variety with two or three competing "information strip malls," tightly controlled by telephone and cable companies. Such an outcome is one that the U.S. can ill afford.

Network Neutrality, Product Differentiation, and Social Welfare

Response to Phoenix Center's Reply

A Policy White Paper Prepared by

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June 22, 2006

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Executive Summary

Phoenix Center Policy Paper No. 24 argues that network neutrality harms consumers and creates social inefficiency. I responded to Policy Paper No. 24 and identified four fatal flaws in Phoenix's approach. Because of these flaws, Phoenix's conclusions regarding network neutrality are unsupported. The four flaws in Phoenix Policy Paper No. 24 are:

> Phoenix's economic modeling does not address economies of scale in last-mile broadband networks.
>
> Phoenix's economic modeling assumes policy makers, by pursuing a policy of network neutrality, can completely eliminate product differentiation among broadband providers.
>
> Phoenix fails to acknowledge the impact of the abandonment of network neutrality on the consumption and production of Internet content, services, and applications.
>
> Finally, Phoenix draws conclusions from their model that depend on the existence of low levels of sunk costs associated with constructing new last-mile networks. Within the context of their model, as well as in reality, this assumption is highly unrealistic.

Phoenix has published a reply to my response. Their reply does nothing to undermine my original criticism. In this paper I evaluate and respond to Phoenix's reply. I take a more detailed look at Phoenix's economic model, and compare Phoenix's current interpretation of entry and competition in last-mile telecommunications networks with Phoenix's previous analysis of these issues. I conclude that Phoenix continues to get it wrong with regard to network neutrality policy.

This paper also notes that Phoenix has published "Policy Bulletin No. 16," which renews their claims that network neutrality will cause social inefficiency. However, this new Phoenix research relies heavily on the economic arguments contained in Phoenix Policy Paper No. 24, thus Phoenix's additional claims that network neutrality harms society rest on very shaky ground.

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Introduction

Economic models are useful because they can simplify complex situations and cut away unnecessary details. However, economic models, if they are to be useful to policymakers, must reasonably reflect the reality which they are purporting to simplify. In my paper, "Network Neutrality, Product Differentiation, and Social Welfare,"[1] I provide a critique of Phoenix Center Policy Paper Number 24.[2] In that paper, I take issue with the Phoenix Center's application of an economic model to matters surrounding the network neutrality debate. I argue that the model applied by Phoenix Center to evaluate network neutrality does not do a very good job of reflecting the market reality which provides the backdrop to the debate. The Phoenix Center has now responded to my criticism,[3] which now inspires this response. While I appreciate Phoenix Center's efforts to clarify their position, nothing in their Reply undermines my original criticism of their work.

Scale Economies

In my critique of Phoenix Policy Paper No. 24, I pointed out that Phoenix's analysis did not reflect scale economies. Phoenix has previously provided a reasonable assessment of the nature of the scale economies associated with last-mile telecommunications facilities, including those utilized to provide broadband:

> The construction of a local communications network – whether used for voice, video, data or some combination thereof – requires enormous capital expenditures.

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[1] Available at: http://www.roycroftconsulting.org/response_to_Ford.pdf

[2] Phoenix Policy Paper No. 24. George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Network Neutrality and Industry Structure," April 2006. Available at: http://www.phoenix-center.org/ppapers.html

[3] Phoenix Center for Advanced Legal & Public Policy Studies. *Network Neutrality and Scale Economies: A Response to Dr. Roycroft*, May 2006. (Hereinafter, "Phoenix Reply to Dr. Roycroft.") Available at: http://www.phoenix-center.org/RoycroftResponseFinal.pdf

> These expenditures are fixed costs and, consequently, firms in these markets have considerable economies of scale (i.e., average costs fall as output increases). The presence of these significant scale economies results in highly-concentrated market structures, since larger firms operate at a sizeable cost advantage over smaller firms.[4]

To summarize the key points which Phoenix previously recognized: Last-mile broadband networks require huge capital expenses; these capital expenses are largely fixed costs (which are primarily sunk);[5] these fixed costs result in "significant" scale economies; significant scale economies result in cost advantages for large (incumbent) firms, and a highly concentrated market.

In Phoenix's Reply, they point to various discussions in Policy Paper No. 24 to demonstrate that economies of scale "play a key role in the analysis" that they conduct.[6] Let us consider whether the economic model Phoenix selects to analyze entry in last-mile telecommunications markets comports with the facts that Phoenix has elsewhere recognized. Specifically, does Phoenix's approach in Policy Paper No. 24 reflect the "significant" scale economies which are present in last-mile markets?

Phoenix's Modeling Choice: the Cournot Model

To model last-mile network entry, Phoenix has selected the Cournot model. The Cournot model assumes that firms compete by deciding what level of output to produce, and, as applied by Phoenix, is a static, one-shot entry game.[7] When a Cournot game is played, the Cournot assumption is that each firm takes the level of output of its rival as given, and then decides how

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4 Phoenix Policy White Paper No. 21, July 2005, p. 8.

5 *Id.*, p. 3.

6 Phoenix Reply to Dr. Roycroft, p. 3.

7 The Cournot model, while predating modern game theory, is widely recognized as a precursor to game theoretic analysis. Thus, I discuss Cournot in terms of game play. See, for example, Friedman, J. *Game Theory with Applications to Economics*, Oxford University Press, New York, 1986, p. 22.

much to produce.[8] When the entrant and incumbent are roughly equal-sized firms, with no firm having superior market advantage, or when no firm exercises a leadership position, Cournot may be a reasonable approach to predict how firms will behave. Cournot modeling may make the most sense if marginal costs are sharply rising.[9] These assumptions are completely out of sync with empirical evidence regarding market conditions in last-mile telecommunications networks, where incumbents have tremendous market advantages, where entrants are likely to face higher costs than incumbents, and where marginal costs are falling.

With Phoenix's application of the Cournot model:

- The incumbent and entrant face the same *constant* marginal costs of production, in other words, no firm has a cost advantage.[10]

Thus, Phoenix's use of Cournot does not comport with what we observe in a marketplace characterized by scale economies, i.e., cost advantages for incumbents and declining marginal costs.[11]

When Phoenix's Cournot game is played, the following outcome is observed if entrants can differentiate their product, and sunk costs are not "too large":

- In equilibrium, the incumbent and entrant split the market and earn equal profits.[12]

This outcome reflects the fact that the incumbent has no cost or other market advantages in Phoenix's model, therefore, entrants face incumbents who accommodate entry and share the

8 Pindyck, R., and Rubinfeld, D. *Microeconomics,* MacMillan, 1989, p. 428.

9 Tirole, J. *The Theory of Industrial Organization*, MIT Press, 1989, p. 224.

10 Phoenix Policy Paper No. 24, p. 12. This is not a requirement of Cournot, but Phoenix does not explore the case where marginal costs differ.

11 Phoenix concedes that a model which introduced declining marginal costs might serve as an alternative interpretation of market outcomes where scale economies are present. Phoenix Reply to Dr. Roycroft, p. 4, footnote 9.

12 Phoenix Policy Paper No. 24, p. 16.

market.

Thus, according to Phoenix's application of Cournot, absent product differentiation, a "natural monopoly" market outcome results.[13] However, the "natural monopoly" with which Phoenix's model begins can be overcome if the entrant differentiates its product, even by a little bit. The market outcome in Phoenix's Cournot model, when product differentiation is allowed, is an incumbent that accommodates entry (rather than fighting entry).

Does the story told by Phoenix's Cournot model comport with the reality of an incumbent operating with "substantial" scale economies and cost advantages over its rivals, as is reasonable to expect in last-mile telecommunications markets? Phoenix's model's prediction is that a monopolist's response to entry by a firm which offers a slightly differentiated product is to accommodate and share the market. Clearly this is not a reasonable expectation when incumbents are dominant firms. Substantial scale economies award the incumbent cost and market advantages which are not acknowledged in Phoenix's modeling approach. Phoenix's analysis indicates that the incumbent cannot capitalize on the advantages which are driven by substantial scale economies (or take advantage of any other benefit which incumbents have at their disposal, such as first mover advantages, the ability to raise its rivals costs, or superior access to capital, rights of way, or multi-tenant buildings). Phoenix's model simply says: faced with entry prospects, incumbents accommodate and share the market. This outcome does not reflect a market characterized by significant scale economies.

Is Cournot the Only Way to Think About Last-Mile Markets?

Is there another way to think about, and model, the behavior of entrants and incumbents in last-mile telecommunications markets? If "significant scale economies" (as well as sunk

[13] Phoenix Reply to Dr. Roycroft, p. 4.

costs) are present, and "larger firms operate at a sizeable cost advantage over smaller firms," then a market is better explained with a *dominant firm* approach.[14] In Phoenix Policy Paper No. 12, titled "Why ADCo? Why Now?," Phoenix used a dominant firm model to explain why it is good policy to encourage the provision of last-mile networks on a "neutral" basis.[15] In "Why ADCo?" Phoenix points out the inherent conflict of interest associated with an integrated last-mile network provider that offers retail services, and which also provides access to its network facilities for competing retail firms to reach their customers.[16] Specifically, Phoenix finds that in these circumstances an incumbent will have the incentive to "sabotage and discriminate against rivals."[17]

In "Why ADCo?" Phoenix concludes that the entry of an unintegrated last-mile network provider (the "alternative distribution company" or ADCo) that allows unaffiliated third-party retail providers equal access to the last-mile will have the following favorable result:

> [W]hile the number of local access networks the market can sustain may be few, the wholesale nature of the ADCo nonetheless permits the number of providers of advanced telecoms products and services to be many.[18]

Thus, Phoenix observed that in spite of market conditions dictating that competing last-mile

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[14] See, for example, Carlton, D. And Perloff, J. *Modern Industrial Organization, 4th Ed.* Pearson Addison Wesley, 2005, pp. 111-112.

[15] Phoenix Center Policy Paper Number 12: "Why ADCo? Why Now? An Economic Exploration into the Future of Industry Structure for the 'Last Mile' in Local Telecommunications Markets," November 2001. The authors of Phoenix Policy Paper No. 24, George Ford and Lawrence Spiwak, are coauthors of the "Why ADCo?" paper.

Their dominant firm model appears on pp. 23-25. The benefits of a neutral last - mile network are discussed on p. 40 and *passim.*

[16] "Why ADCo?", pp. 34-35.

[17] *Id.*, p. 35.

[18] *Id.*, p. 40.

networks are few, competition for advanced retail services can be achieved if a neutral last-mile platform is available, in other words—nondiscrimination (network neutrality) encourages retail competition over last-mile networks where facilities-based competition is unlikely.

Given the difference in Phoenix's approach to interpreting last-mile markets in "Why ADCo?" and Policy Paper No. 24, its fair to consider whether Phoenix is addressing different underlying market structures. Phoenix's position on the nature of last-mile telecommunications networks in Policy Paper No. 24 is described by Phoenix as follows:

> We set out to analyze how Network Neutrality rules would affect industry structure in a market that is characterized by economies of scale, and fixed and sunk costs.[19]

Phoenix also indicates that it currently expects the fixed and sunk costs to be "large."[20] How did Phoenix perceive the underlying market structure in "Why ADCo?" Was it different than the market structure that Phoenix addresses in Policy Paper No. 24? Clearly not, here is Phoenix's take on market structure from "Why ADCo?":

> [T]his Policy Paper. . . explains that entry into the local exchange market requires large fixed and sunk costs, making entry risky and necessitating scale economies.[21]

Thus, in "Why ADCo?" the market structure they describe is the same as the last-mile world they model in Phoenix Policy Paper No. 24, i.e., fixed and sunk costs and scale economies prevail. However, the logical description of market conditions which Phoenix acknowledged in "Why ADCo?" is not reflected in Phoenix's modeling approach in Policy Paper No. 24, where they do not employ a dominant firm approach.

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19 Phoenix Reply to Dr. Roycroft, p. 3.

20 *Id.*

21 Phoenix Center Policy Paper Number 12: "Why ADCo? Why Now? An Economic Exploration into the Future of Industry Structure for the "Last Mile" in Local Telecommunications Markets," November 2001, p. 1.

Furthermore, it is clear from Phoenix's discussion in "Why ADCo?" that the economics of telecommunications market entry that they modeled with a dominant firm approach applied to broadband markets. In "Why ADCo?" Phoenix discussed the last-mile broadband provider RCN to make the point that the business case for last-mile entry was tenuous:

> The inability of local telecoms markets to support large numbers competition can be illustrated by example. Telecommunications firm RCN targets residential customers in densely populated markets with its own network facilities over which it provides telephone, data and video services. According to its financial documents, RCN has $2.75 billion in plant and passes about 1.5 million homes, or 1.1 million marketable homes. Network costs run about $1,750 per home passed, $2,500 per marketable home, or about $6,500 per customer. A rough estimate of RCN's monthly plant costs (assuming a 15% hurdle rate and 15 year payoff) is about $25 per home passed. Average revenue per subscriber per month is about $130 and direct costs are about 46% of revenues, implying a gross monthly margin of about $68 per subscriber. In order to cover plant costs with its net revenues, RCN needs a penetration rate of about 35%-40% (and that is in the more densely populated markets targeted by RCN over a network capable of generating services worth $130 per subscriber). Notably, if a 35%-40% penetration is required for profitability, then only two firms can profitably service the same market, and RCN and the incumbent makes two. To construct an RCN-style network for every household in the U.S., the plant investment and total entry costs would be about $300 billion and $600 billion, respectively. Clearly, network-based entry is incredibly costly and not something that is replicable by numerous firms in the same market.[22]

Phoenix's previous view of the difficulties facing a last-mile broadband provider, as illustrated by RCN's experience, was reasonable. In fact, RCN filed for Chapter 11 bankruptcy protection in 2004, and has yet to return to profitable operations.[23]

Phoenix's Cournot approach to modeling entry in last-mile markets in Policy Paper No. 24 does not reflect the reality they previously recognized. Last-mile telecommunications competition faces an uphill battle, and incumbents hold a decided market advantage. It is entirely unreasonable to expect, as Phoenix does, that incumbents will not leverage their market

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[22] Phoenix Center Policy Paper Number 12: "Why ADCo? Why Now? An Economic Exploration into the Future of Industry Structure for the "Last Mile" in Local Telecommunications Markets," November 2001, pp. 11-12.

[23] RCN Corporation, 10-K, December 31, 2005, p. 6.

advantages, including the advantages associated with scale economies, and fight entry.

When Dominant Firms are Present, a Neutral Last-Mile Network Serves the Public Interest

In "Why ADCo?" Phoenix's policy vision called for the entry of a "wholesale-only carriers-carrier"[24] (the ADCo) which provides a neutral platform over which market entrants can sell retail services. Phoenix concluded that such an arrangement would serve the public interest.[25] Apparently, Phoenix does not see the parallel between a neutral wholesale network allowing retail service providers to reach their customers, and neutral last-mile broadband Internet access facilities which allow third-party providers of Internet content, applications, and services to reach their customers. Nor does Phoenix currently see the incentives which integrated incumbent last-mile providers have to disadvantage non-integrated rivals, even though it previously recognized these incentives. In "Why ADCo?" Phoenix was well aware of the power that a dominant firm has to disadvantage its rivals, and Phoenix indicated that "*to the extent that the incumbent dominant firm is able to impose costs on rivals, its incentives are to do so.*"[26] It is entirely reasonable to expect that a dominant last-mile broadband provider will disadvantage its rivals in a similar fashion, another lesson Phoenix has now forgotten. Dominant firms in last-mile markets make network neutrality the best policy.

In summary, Phoenix has now taken an economic position on the nature of entry in last-mile broadband networks that does not address the significant scale economies and sunk costs which hinder market entry. In "Why ADCo?" Phoenix noted:

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24 Phoenix Center Policy Paper Number 12: "Why ADCo? Why Now? An Economic Exploration into the Future of Industry Structure for the "Last Mile" in Local Telecommunications Markets," November 2001, p. 2.

25 *Id.*, p. 36.

26 *Id*, p. 29, emphasis in the original.

> The economics of the telecommunications industry, particularly the supply-side economics, have not changed that much over time. Fewness in supply is the rule, not the exception. Instead, fiber optics, and other technological innovations, notwithstanding the inherent economies of scale and sunk costs of telecommunications networks, remain key drivers of industry structure. As Professors Carl Shapiro and Hal Varian succinctly state in their book INFORMATION RULES: "*Technology Changes. Economic laws do not.*"[27]

Phoenix can't have it both ways. Significant scale economies in last-mile markets result in a dominant incumbent that is willing to disadvantage its rivals and fight entry. We can't reasonably expect, as Phoenix does in Policy Paper No. 24, that an incumbent which commands the advantages of significant scale economies will accommodate entry and share the market.

Product Differentiation

Phoenix's basic premise in Policy Paper No. 24 with regard to product differentiation is that policymakers, by enforcing a policy of network neutrality, can eliminate all product differentiation between last-mile networks. Phoenix Center's Reply indicates that I have misunderstood their assumptions regrading product differentiation, and that their model "allows one to establish different degrees of permissible differentiation."[28] Phoenix's argument is not on point.

Within the context of their model, the parameter in question is represented by the Greek letter Theta (θ). In their Reply, Phoenix argues that θ can take on any value, "from identical goods ($\theta = 1$) to completely differentiated goods ($\theta = 0$), and everything in between."[29] Phoenix's Reply is a red herring. In Policy Paper No. 24, their conclusion regarding the undesirable nature of network neutrality is based on their analysis of the value which θ takes in

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27 *Id.*, p. 39, emphasis in the original.

28 Phoenix Reply to Dr. Roycroft, p. 5.

29 *Id.*

equilibrium. Specifically, they state: "*Without Network Neutrality requiring $\theta = 1$, a firm may enter with $\theta < 1$,*" as long as sunk costs "are not too large."[30] Thus, it is not the case, as suggested by Phoenix's Reply, that θ can "take on any value" for purposes of policy measures designed to enforce network neutrality, as defined in their model. Rather, the key assumption in Policy Paper No. 24, on which their conclusion fully rests, is that policymakers can force $\theta = 1$. If policymakers can't force $\theta = 1$, then entry will occur (if sunk costs are not too high).

In my original response to Phoenix, I pointed out that policymakers would have a difficult time preventing all product differentiation, as network neutrality principles are consistent with both marketing differences (e.g., how much bandwidth is sold), and with inherent technological differences across broadband platforms (e.g., low-bandwidth mobility vs. high-bandwidth fixed). Phoenix, in its Reply, now suggests that these marketing and technology differences are not really differentiation.[31] They accuse me of assuming "technological determinism."[32] Given Phoenix's previous writings on product differentiation, this is a puzzling accusation. Phoenix Center has previously recognized that technological differences across platforms can introduce differentiation:

> A recent study by the General Accounting Office ("GAO") on competition between cable television and DBS firms illustrates the importance of product differentiation. While both terrestrial and satellite multichannel video providers offer similar products, there are some meaningful forms of differentiation between the two. The differences in the delivery technology itself (i.e., inter-modality) are not lost on consumers.[33]

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30 Phoenix Center Policy Paper No. 24, p. 18, emphasis added.

31 Phoenix Reply to Dr. Roycroft, p. 6.

32 *Id.*

33 George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Competition After Unbundling: Entry, Industry Structure and Convergence," Phoenix Center Policy Paper Number 21, July 2005, p. 24. Available at:

(continued...)

It's not clear why consumers of video services will be able to identify "meaningful forms of differentiation" resulting from "differences in delivery technology," while broadband customers will not. Thus, within the context of their model, differentiation sufficient to result in $\theta < 1$ is likely, regardless of policy decisions regarding network neutrality. Phoenix falsely concludes that network neutrality policy could eliminate all differentiation and prevent entry.

Finally, on the issue of product differentiation, Phoenix states that my analysis indicates that recent drafts of network neutrality legislation are "unenforceable."[34] Phoenix's illogic on this point is based on the premise that prohibitions on discrimination, such as those which have been included in draft legislation, would somehow trump technology differences which create the differentiation which Phoenix's model predicts will encourage entry. Network neutrality principles do not rule out technical or marketing differentiation, they simply rule out discrimination. In "Why ADCo?" Phoenix recognized the major problems that discrimination creates, and the overwhelming incentives that incumbents have to discriminate:

> [T]he ADCo provides a viable economic solution for new entrants to the problems raised by the inherent incentive of an incumbent to unduly discriminate to protect its profits. This issue of incentives is key to understanding the current ills of the market, as it is now clear that policymakers significantly under-estimated the significant incentives of the incumbents to unduly discriminate against their rivals (not to mention . . . underestimating the entry costs of the local market).[35]

Network neutrality principles are a much more modest solution to the discriminatory incentives faced by incumbents than structural separation, which was previously identified by Phoenix as

[33](...continued)
http://www.phoenix-center.org/ppapers.html

[34] Phoenix Reply to Dr. Roycroft, p. 6.

[35] Phoenix Policy Paper No. 12, "Why ADCo?", pp. 7-8.

the best way to address the incumbent's incentives to discriminate.[36]

Upstream Competition

Abandonment of Network Neutrality principles will have definite consequences on the delivery of content, services, and applications over last-mile broadband facilities. Competition and innovation at the network edge could be damaged by gatekeepers in the last mile. In my original paper, I was critical of Phoenix's analysis as its model did not address the loss of social welfare that is likely to arise if competition and innovation at the network edge are harmed.

Phoenix states in its Reply that it was concerned about these issues, and points to two passages from Policy Paper No. 24 as proof.[37] While it is appreciated that these passages do pay lip service to the proposition that abandonment of network neutrality could lead to some other harms, Phoenix did not include these negative consequences in its modeling exercise, and otherwise ignores the larger issue of the harm to upstream competition. Most important, their social welfare analysis, as well as the mathematical proof which provides the entire economic basis for their conclusions, fails to incorporate the potential harm to upstream competition. This results in an incomplete analysis of the proposed policy change. When Phoenix states in its mathematical proof that if sunk costs of entry are "not too large, then Network Neutrality is socially inefficient,"[38] the "social inefficiency" is completely devoid of any consideration of the impact on upstream markets. This oversight makes Phoenix's analysis incomplete and incapable of lending any guidance to policymakers on the issue of network neutrality.

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[36] *Id.*. p. 8.

[37] Phoenix Reply to Dr. Roycroft, pp. 6-7.

[38] Phoenix Policy Paper No. 24, p. 18.

The Level of Sunk Costs

In my response to Phoenix Policy Paper No. 24, I pointed out that their analysis hinged on a low level of sunk costs. Phoenix says that their analysis depends on sunk costs which are "not too large." In its reply, Phoenix provides a rather entertaining exercise in illogic to support the proposition that "low level" and "not too large" are entirely different concepts.[39]

Of course, sunk costs of entry in the telecommunications industry in general, and the last-mile broadband market in particular, are very large. This fact has been previously acknowledged by the Phoenix Center:

> As consistently demonstrated by academic and Phoenix Center research, and again in this POLICY PAPER, given the *huge fixed and sunk costs* inherent to the construction and commercial operation of communications networks, the equilibrium level of concentration of terrestrial firms in local communications markets (voice, video, and data) will be relatively high. . . . *fewness arises because scale economies and sunk costs limit the number of firms that can profitably serve a market – and local communications networks are notoriously riddled with scale economies and sunk costs.* Any policymaker interested in local communications markets should, therefore, start from the assumption that there will, at best be only a "few" facilities-based firms.[40]

Furthermore, sunk costs of market entry are not just limited to the tremendous up-front costs of building a network. As Phoenix has previously observed:

> On average, however, net plant amounts to about 37% (approximately two-thirds) of total entry costs. . . . In other words, for every dollar of investment in plant and equipment, an additional $2 of entry costs are incurred on average. There is no reason to suspect that these additional entry costs are less sunk than plant and equipment, but good reason to believe such costs are more sunk.[41]

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39 Phoenix Reply to Dr. Roycroft, pp. 7-8.

40 George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, "Competition After Unbundling: Entry, Industry Structure and Convergence," Phoenix Center Policy Paper Number 21, July 2005, emphasis added. Available at: http://www.phoenix-center.org/ppapers.html

41 Phoenix Center Policy Paper Number 12: "Why ADCo? Why Now? An
(continued...)

Given these facts, it is clear that Phoenix's attempt to paint "low" and "not too large" as diametrically opposites is another red herring.

As is noted by Phoenix, their mathematical proof associated with the level of sunk entry costs which will deter entry "provides a method to determine how small or large entry costs need to be for Network Neutrality rules to be inefficient."[42] However, now with two opportunities, Phoenix has not utilized this "method to determine how small or large entry costs need to be" to provide any absolute numerical value, or relative evaluation, of what level of sunk costs deter entry within the context of their model. They say they can do it, but they don't. Let's consider why that might be.

Phoenix's modeling approach is a one-shot game. Interpreting the impact of sunk costs within the context of a one shot game is likely to drive the entry-deterring threshold level of sunk costs to an extremely low level, as the entrant has only one period of play to earn profits sufficient to justify the sunk investments. In other words, within the context of Phoenix's model, the entrant must be able to justify the recovery of all sunk costs in a short period of time, thus making it imperative that the sunk costs are negligible for entry to be feasible. So, within the context of their modeling exercise, Phoenix's one-shot game makes it likely that a very low level of sunk costs will be sufficient to deter entry.

Phoenix might argue that the period of game play could be long enough to allow for the recovery of sunk costs, but such an assumption would create further inconsistencies. Sunk assets may be long-lived and interpreting a "one-shot" interaction which lasts over a period long

[41](...continued)
Economic Exploration into the Future of Industry Structure for the "Last Mile" in Local Telecommunications Markets," November 2001, p. 14.

[42] Phoenix Reply to Dr. Roycroft, p. 8.

enough to allow for the recovery of long-lived sunk costs is necessarily contradictory. Recall that an assumption of the Cournot model is that players of the game do not expect that other players will change their output during the play of the game. Holding this expectation over a long period of time is entirely unreasonable. Of course, to give the game a longer period of play, Phoenix could have selected a modeling approach which assumed that the Cournot game was repeated. However, when Cournot games are repeated, it is easy to show that incumbents are very likely to fight entry and attempt to drive rivals out.[43] This reality is one that Phoenix now prefers to ignore.

Conclusion

Policymakers need sound economic advice when considering issues associated with network neutrality. Economic analysis may be able to assist with this process. However, theoretical economic analysis must be reasonably consistent with empirical evidence regarding the nature of the market and the behavior of incumbent firms. The economic analysis contained in Phoenix Policy Paper No. 24 is entirely unsatisfactory as a result. Phoenix does not provide any economic evidence that network neutrality might be economically inefficient or harmful to consumers or society. Nor does their Reply to my critique undermine my conclusion that their approach is fatally flawed.

While Phoenix indicates in Policy Paper No. 24 that they do not take any position on the need for network neutrality rules, they have made their position more clear in their new paper on this matter. In this new research, Phoenix alleges that it has identified "efficiency risks"

[43] See, for example, Friedman, J. *Game Theory with Applications to Economics*, Oxford University Press, New York, 1986, pp. 136-139.

associated with network neutrality policy, based on a benefit/cost analysis.[44] To support their claims, they point to analyses produced by AT&T and BellSouth regarding alleged costs of building network capacity. They also attack views that dissent from the RBOC conclusions. As time permits, I will provide a detailed critique of the numerous problems associated with Phoenix's new research. However, first and foremost among these problems is the fact that Phoenix's new research points repeatedly to Phoenix Policy Paper No. 24 to support Phoenix's new conclusions.[45] Given this indefensible foundation, Phoenix's new claims regarding efficiency risks and network neutrality are dubious.

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44 "The Efficiency Risks of Network Neutrality Rules," Phoenix Policy Bulletin No. 16, May, 2006.

45 *Id.*, pp. 2, 5, 6, & 7.